INNOVATIVE METHODOLOGY FOR DETECTION OF FRACTURE-CONTROLLED SWEET SPOTS IN THE NORTHERN APPALACHIAN BASIN

June 1, 2000-March 31, 2007

TOPICAL REPORT #1

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ABSTRACT

This Topical Report (#1 of 9) consists of the figures 1.1-1a to (and including) 3.1-69 (and appropriate figure captions) that accompany the Final Technical Progress Report entitled: "Innovative Methodology for Detection of Fracture-Controlled Sweet Spots in the Northern Appalachian Basin" for DOE/NETL Award DE-AC26-00NT40698.

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FIGURE CAPTIONS FOR TOPICAL REPORT #1

FIGURE 1.1-1a. **General Location Map of Study Area on a Structure Contour Map of Top of Precambrian in the Appalachian Basin**

White shaded area in central New York indicates location of Figure 1.1-1B. Structure contours after Shumaker (1996).

FIGURE 1.1-1b. **General Location Map of Study Area.**

Four proprietary seismic lines and aeromagnetics were interpreted for this project within the yellow box. In order to preserve the proprietary nature of the seismic interpretation, the actual shot point locations of the seismic lines are not shown. Location of map shown in Figure 1.1-1A.

FIGURE 1.2-1. **Structure Contour Map in Seneca Lake Region.**
Contours are on the base of the Devonian Rhinestreet Formation, which crops out in the study area. Contour interval = 25 ft. (7.6 m). After Bradley et al. (1941).

FIGURE 1.2-2. **Proposed Faults in the Northern Appalachian Basin of New York State.**
Figure after Jacobi (2002).

FIGURE 1.2-3. **Cross Section of the Glodes Corners Road Field.**
Section is based on well logs. After Beardsley (1999, 2001), from Jacobi et al. (2006d).

FIGURE 2.1-1. **Field Areas (Swaths) for Fracture Study.**
Larger font text indicates names of 7.5' topographic quadrangles, whereas boxes with smaller font text indicate place names.

FIGURE 2.1-2. **Legend for Modified Rose Diagrams.**
The top half of the modified rose diagram displays the fracture frequency for each fracture set, and the lower half of the diagram shows the abutting relationships of the fracture sets.

FIGURE 2.1-3. **Schematic Diagram of Fracture Intersection Patterns.**
Lower half of rose diagrams illustrate how the accompanying fracture intersection pattern is indicated on modified rose diagrams (see legend for modified rose diagrams in Figure 4).

FIGURE 2.1-4. **Location of N-S Seneca Lake Transect for ENE- and E-Striking Fractures.** Transect displayed in Figure 3.1-8. Sites were extrapolated to this transect in order to construct Figure 3.1-8.

FIGURE 2.1-5. **E- and ENE-Striking Fracture Frequency at Sites Extrapolated (on an ENE-Strike) to a N-S Seneca Lake Transect**.

FIGURE 2.1-6. **E-Striking Fracture Frequency at Sites Extrapolated (on an E-Strike) to a N-S Seneca Lake Transect**.

FIGURE 2.1-7. **Cayuga Lake Transect Location Map.**
Orange line indicates location of Cayuga Lake Transect shown in Figures 3.1-68 and 69. Small numbers indicate outcrop locations. Red boxes are inserts that are enlarged in figures 3.1-24 to 3.1-43. Green lines are Landsat lineaments from EarthSat (1997).

FIGURE 2.4-1. **Location Map of Interpreted Seismic Lines.**
One proprietary seismic line is located in each of the four swaths. In order to preserve the proprietary nature of the seismic interpretation, the exact shot point locations of the seismic lines are not shown

FIGURE 3.1-1. **Modified Rose Diagrams of Fractures in the Detailed Study Area, East Side of Seneca Lake.**
Legend for modified rose diagrams in Figure 4. From Lugert et al. (2002) and Jacobi et al. (2002a, b).

FIGURE 3.1-2. **Widely-Spaced NNW- and NNE-Striking Fractures.**
One-lane bridge in background provides approximate scale. Location of Figure 3.1-2 shown in Figure 3.1-3. From Lugert et al. (2002) and Jacobi et al. (2002a, b).

FIGURE 3.1-3. **Index Map Showing Locations of Figures With Photographs.**

FIGURE 3.1-4. **ENE-Striking FIDs.**
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FIGURE 3.1-5**. NNW-Striking FIDs. Locations shown in Figure 3.1-3.**
After Lugert et al. (2002) and Jacobi et al. (2002a, b).

FIGURE 3.1-6. **N-Striking Fracture With Dextral Motion.**

To discriminate between strike slip offset and a normal abutting relationship of the E-striking fracture, an arbitrary standard was set that three "abutting" fractures had to show equal (or nearly equal) offset across the "master" fracture in order for the "master" fracture to be considered a fracture along which strike-slip motion had occurred. Thus, in this case, at least two more fractures adjacent to the one shown displayed the same magnitude and sense of offset as the one in the photograph. Location shown in Figure 3.1-3. From Lugert et al. (2002) and Jacobi et al. (2002a, b).

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FIGURE 3.1-8. **N-S Seneca Lake Transect Displaying Fracture Frequency of ENE- and E-Striking Fractures.**
Location of transect shown in Figure 2.1-4. Values are averaged in a 1 km window along the transect from all projected sites. After Lugert et al. (2002) and from Jacobi et al. (2002a, b).

FIGURE 3.1-9. **Enlargement #9 East of Seneca Lake with Modified Rose Diagrams.** Explanation for modified rose diagrams in Figure 2.1-2. Map location shown in Figure 3.1-7. After Lugert et al. (2002) and Jacobi et al. (2002a, b).

FIGURE 3.1-10. **Enlargement #10 East of Seneca Lake with Modified Rose Diagrams.**
Explanation for modified rose diagrams in Figure 2.1-2. Map location shown in Figure 3.1-7. After Lugert et al. (2002) and Jacobi et al. (2002a, b).

FIGURE 3.1-11. **Enlargement #11 East of Seneca Lake with Modified Rose Diagrams.**
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FIGURE 3.1-14. **Enlargement #14 East of Seneca Lake with Modified Rose Diagrams.**
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Explanation for modified rose diagrams in Figure 2.1-2. Map location shown in Figure 3.1-7. After Lugert et al. (2002) and Jacobi et al. (2002a, b).

FIGURE 3.1-18. **Enlargement #18 East of Seneca Lake with Modified Rose Diagrams.**
Explanation for modified rose diagrams in Figure 2.1-2. Map location shown in Figure 3.1-7. After Lugert et al. (2002) and Jacobi et al. (2002a, b).

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FIGURE 3.1-20. **Enlargement #20 with Modified Rose Diagrams.**
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FIGURE 3.1-21. **Location of Tully Transect Along Seneca Lake in Figure 3.1-22.**
Geological cross-section along the transect shown in Figure 3.1-22. Transect location also shown in Figure 1.2-1.

FIGURE 3.1-22a. **Geological Cross-section of the Tully Formation.**
Location shown in Figure 3.1-21.

FIGURE 3.1-22b. **Enlargement of the Northern Portion of the Tully Transect Along Seneca Lake.**
Note that the apparent dips for the cross-section that were measured from outcrops are consistent with the general dip inferred from correlations

among the outcrops. Thus, a fault is not necessary in this part of the transect to explain the large differences in site elevations of the Tully. See Figure 3.1-22a for location.

FIGURE 3.1-22c. **Enlargement of the Southern Portion of the Tully Transect Along Seneca Lake, Fold Alternative**.
Note that the apparent dips for the cross-section that were measured from outcrops are consistent with the general dip inferred from correlations among the outcrops. Thus, a fault is also not necessary in this part of the transect to explain the large differences in site elevations of the Tully. See Figure 3.1-22a for location.

FIGURE 3.1-22d. **Enlargement of the Southern Portion of the Tully Transect Along Seneca Lake, Fault Alternative.**
In this case the apparent dips for the cross section were rigorously applied, which can be used to infer a fault near site RDJ-59. See Figure 3.1-22a for location.

FIGURE 3.1-23. **Location Map for Field Sites and Insets that Display Modified Rose Diagrams of the Cayuga Lake Swath.**
Green lineaments are Landsat lineaments from EarthSat (1997).

FIGURE 3.1-24. **Inset A with Modified Rose Diagrams of the Cayuga Lake Swath.**
For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-25. **Inset B with Modified Rose Diagrams of the Cayuga Lake Swath.**
For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-26. **Inset C with Modified Rose Diagrams of the Cayuga Lake Swath.**
For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-27. **Inset D with Modified Rose Diagrams of the Cayuga Lake Swath.**
For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-28. **Inset E with Modified Rose Diagrams of the Cayuga Lake Swath.**
For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-29. **Inset F with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-30. **Inset G with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

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FIGURE 3.1-34. **Inset K with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-35. **Inset L with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-36. **Inset M with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-37. **Inset N with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-38. **Inset O with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-39. **Inset P with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

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FIGURE 3.1-41. **Inset R with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-42. **Inset S with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-43. **Inset T with Modified Rose Diagrams of the Cayuga Lake Swath.** For location, see Figure 3.1-23. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half (see Figure 2.1-2).

FIGURE 3.1-44. **Location Map for Field Sites and Combined Data Maps in the Cayuga Lake Swath**.
Green lineaments are Landsat lineaments from EarthSat (1997). The Northern, Central, and Southern map areas are shown in figures 3.1-45, 3.1-46, and 3.1-47, respectively.

FIGURE 3.1-45. **Northern Combined Map in the Cayuga Lake Swath.**
Although all sites are shown, the map displays rose diagrams for only fracture intensification domains (FIDs). See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams. Solid green lineaments are Landsat lineaments from EarthSat (1997) that are confirmed by nearby FIDs. See Figure 3.1-44 for location of figure.

FIGURE 3.1-46. **Central Combined Map in the Cayuga Lake Swath.**

Although all sites are shown, the map displays rose diagrams for only fracture intensification domains (FIDs). See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams. Solid green lineaments are Landsat lineaments from EarthSat (1997) that are confirmed by nearby FIDs. See Figure 3.1-44 for location of figure.

FIGURE 3.1-47. **Southern Combined Map in the Cayuga Lake Swath.**
Although all sites are shown, the map displays rose diagrams for only fracture intensification domains (FIDs). See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams. Solid green lineaments are Landsat lineaments from EarthSat (1997) that are confirmed by nearby FIDs. See Figure 3.1-44 for location of figure.

FIGURE 3.1-48. **Inset A Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-45. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-49. **Inset B Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-45. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-50. **Inset C display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-45. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-51. **Inset D Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-45. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-52. **Inset E Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-45. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-53. **Inset F Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-45. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships

in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-54. **Inset G Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-45. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-55. **Inset H Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-46. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-56. **Inset I Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-46. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-57. **Inset J Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-46. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-58. **Inset K Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-46. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-59. **Inset L Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-46. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-60. **Inset M Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-46. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-61. **Inset N Display of FIDs in the Cayuga Lake Swath.**

For location, see Figures 3.1-44 and 3.1-46. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-62. **Inset O Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-46. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-63. **Inset P Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-47. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-64. **Inset Q Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-47. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

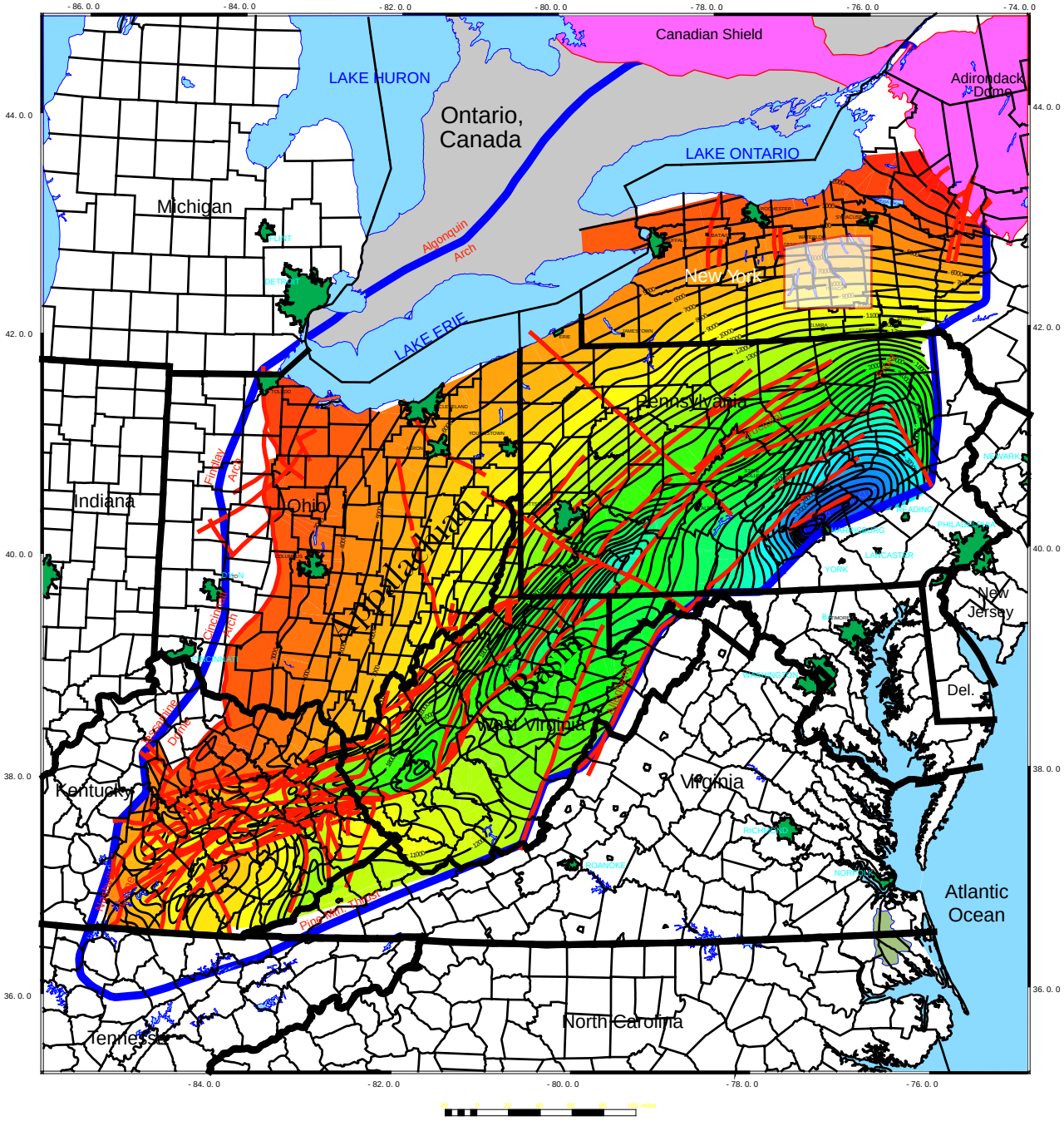
FIGURE 3.1-65. **Inset R Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-47. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-66. **Inset S Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-47. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-67. **Inset T Display of FIDs in the Cayuga Lake Swath.**
For location, see Figures 3.1-44 and 3.1-47. Modified rose diagrams show fracture frequency in the upper half and fracture intersection relationships in the lower half. See Figure 2.1-2 for explanation of the lower semi-circle on the rose diagrams.

FIGURE 3.1-68. **Transect on West Side of Cayuga Lake that Compares E-striking Fracture Frequency to E-striking Landsat Lineaments from EarthSat (1997).**
For location of transect, see Figure 2.1-7.

FIGURE 3.1-69. **Transect on the West Side of Cayuga Lake that Compares ENE-Striking Fracture Frequency to ENE-Striking Landsat Lineaments from Earthsat (1997).**
For location of transect, see Figure 2.1-7.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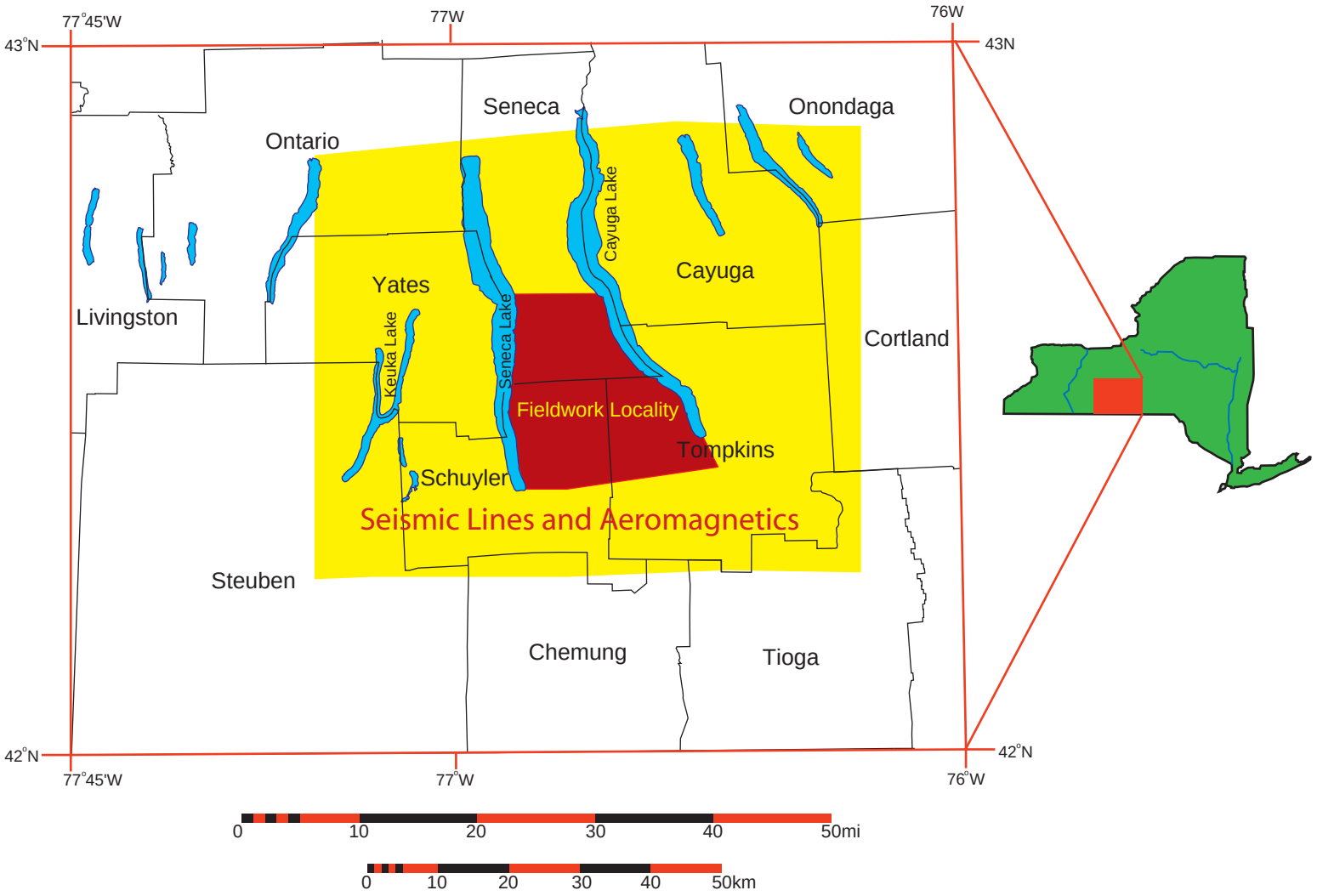
LAKE HURON
Ontario, Canada
Adirondack Dome
LAKE ONTARIO
Michigan
Algonquin Arch
New York
LAKE ERIE
Pennsylvania
Findlay Arch
Indiana
Ohio
Cincinnati Arch
Kentucky
West Virginia
Virginia
New Jersey
Del.
Atlantic Ocean
North Carolina
Tennessee
- 86. 0. 0
- 84. 0. 0
- 82. 0. 0
- 80. 0. 0
- 78. 0. 0
- 76. 0. 0
- 74. 0. 0
44. 0. 0
42. 0. 0
40. 0. 0
38. 0. 0
36. 0. 0

FIGURE 1.1-1a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77W
76W
43°N
43N
Seneca
Onondaga
Ontario
Cayuga Lake
Cayuga
Yates
Livingston
Keuka Lake
Seneca Lake
Cortland
Fieldwork Locality
Tompkins
Schuyler
Seismic Lines and Aeromagnetics
Steuben
Chemung
Tioga
42°N
42°N
77°45'W
77°W
76°W
0 10 20 30 40 50mi
0 10 20 30 40 50km

FIGURE 1.1-1b

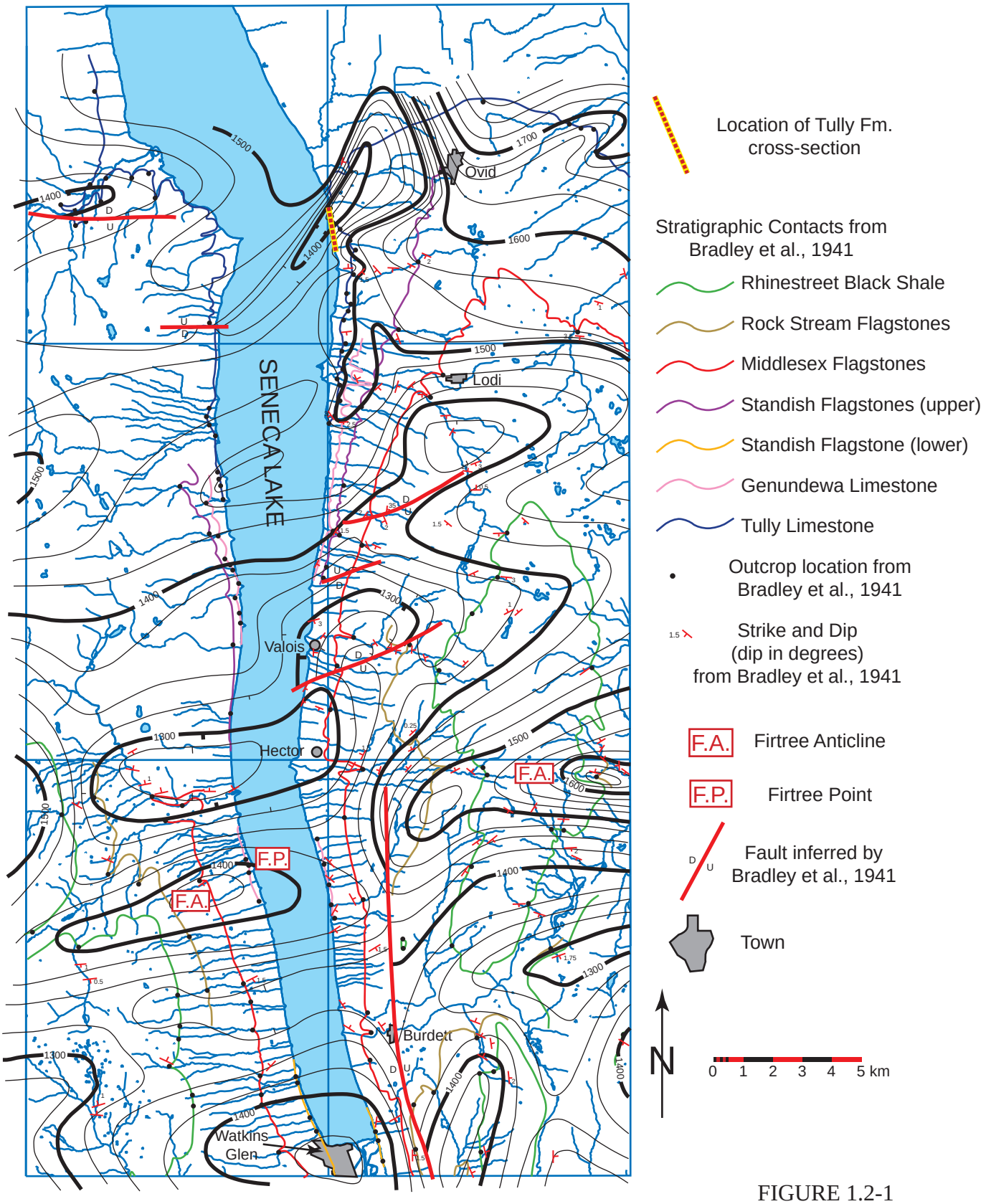

SENECA LAKE
Ovid
Lodi
Valois
Hector
Burdett
Watkins Glen
F.A.
F.P.
Location of Tully Fm. cross-section
Stratigraphic Contacts from Bradley et al., 1941
Rhinestreet Black Shale
Rock Stream Flagstones
Middlesex Flagstones
Standish Flagstones (upper)
Standish Flagstone (lower)
Genundewa Limestone
Tully Limestone
Outcrop location from Bradley et al., 1941
Strike and Dip (dip in degrees) from Bradley et al., 1941
Firtree Anticline
Firtree Point
Fault inferred by Bradley et al., 1941
Town
N
0 1 2 3 4 5 km

FIGURE 1.2-1

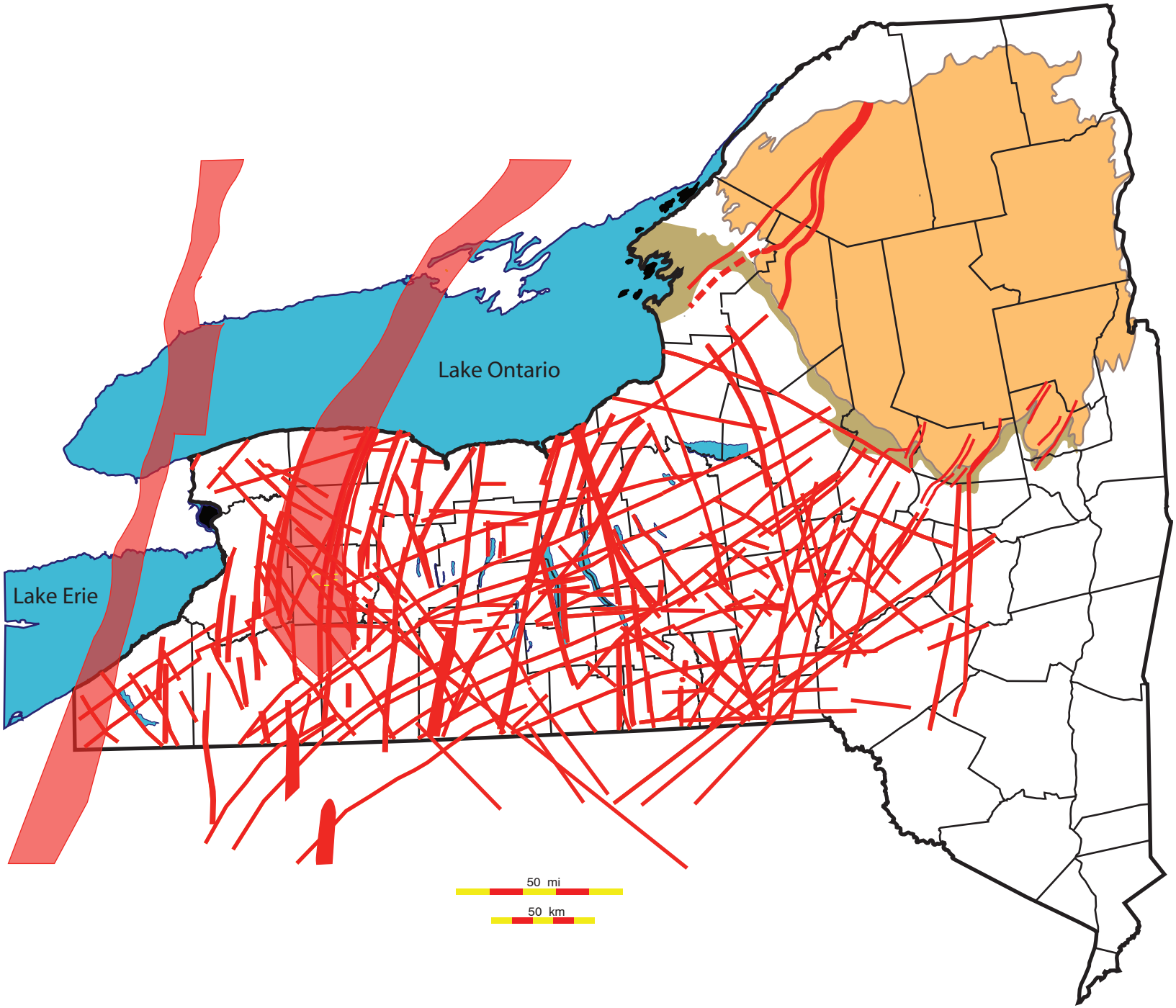


FIGURE 1.2-2

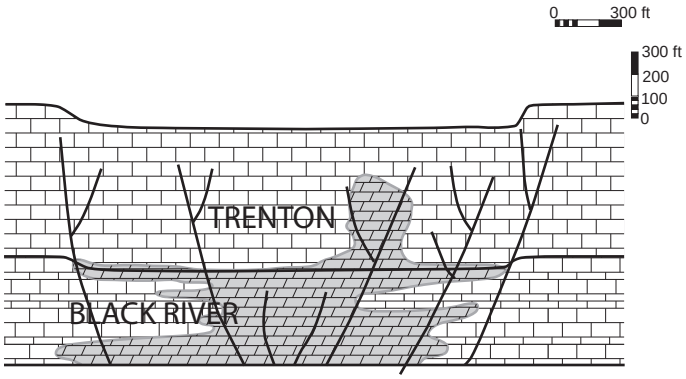


FIGURE 1.2-3

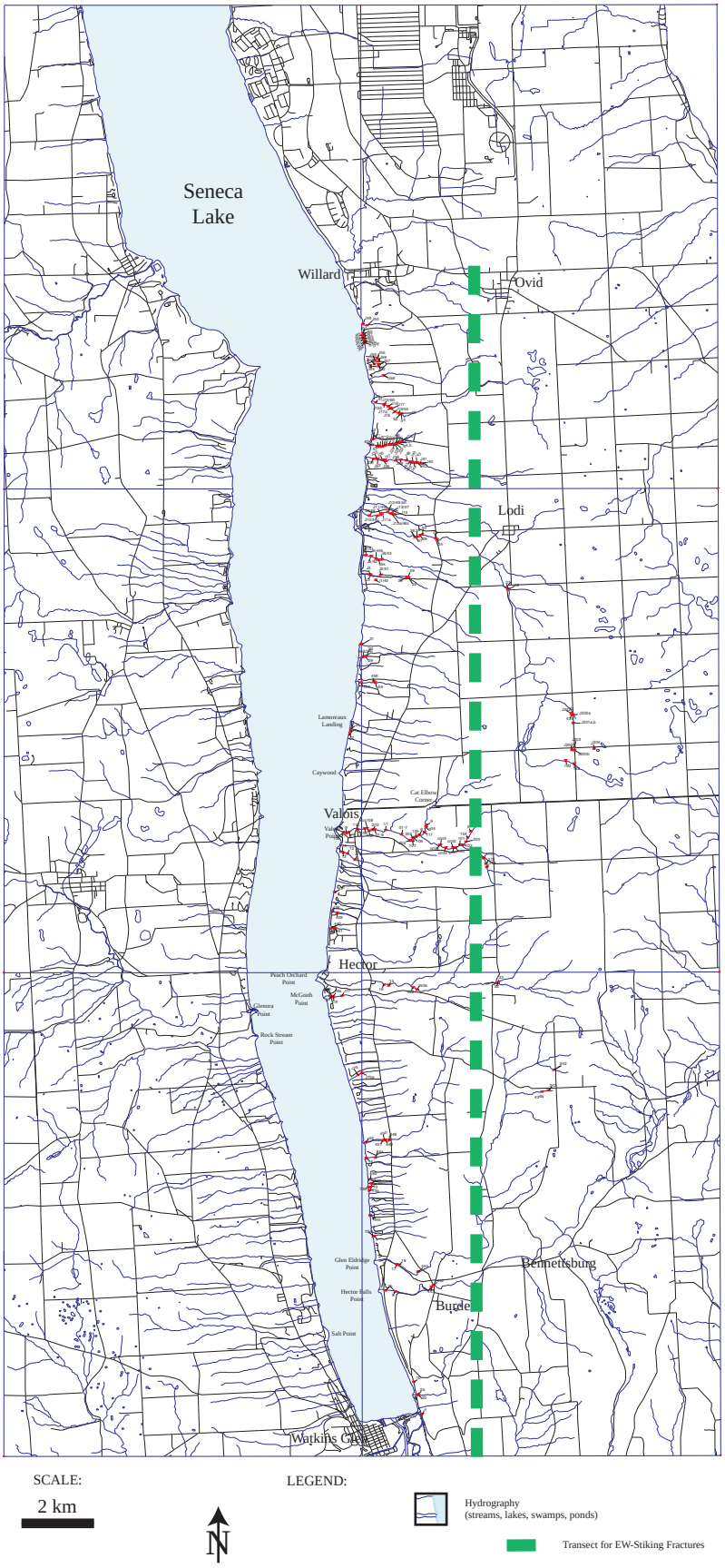

Seneca
Lake
Willard
Ovid
Lodi
Lamoreaux
Landing
Caywood
Cat Elbow
Corners
Valois
Hector
Peach Orchard
Point
McGrath
Point
Glenora
Point
Rock Stream
Point
Glen Eldridge
Point
Hector Falls
Point
Salt Point
Bennettsburg
Burdett
Watkins Glen
SCALE:
2 km
N
LEGEND:
Hydrography
(streams, lakes, swamps, ponds)
Transect for EW-Stiking Fractures

FIGURE 2.1-4

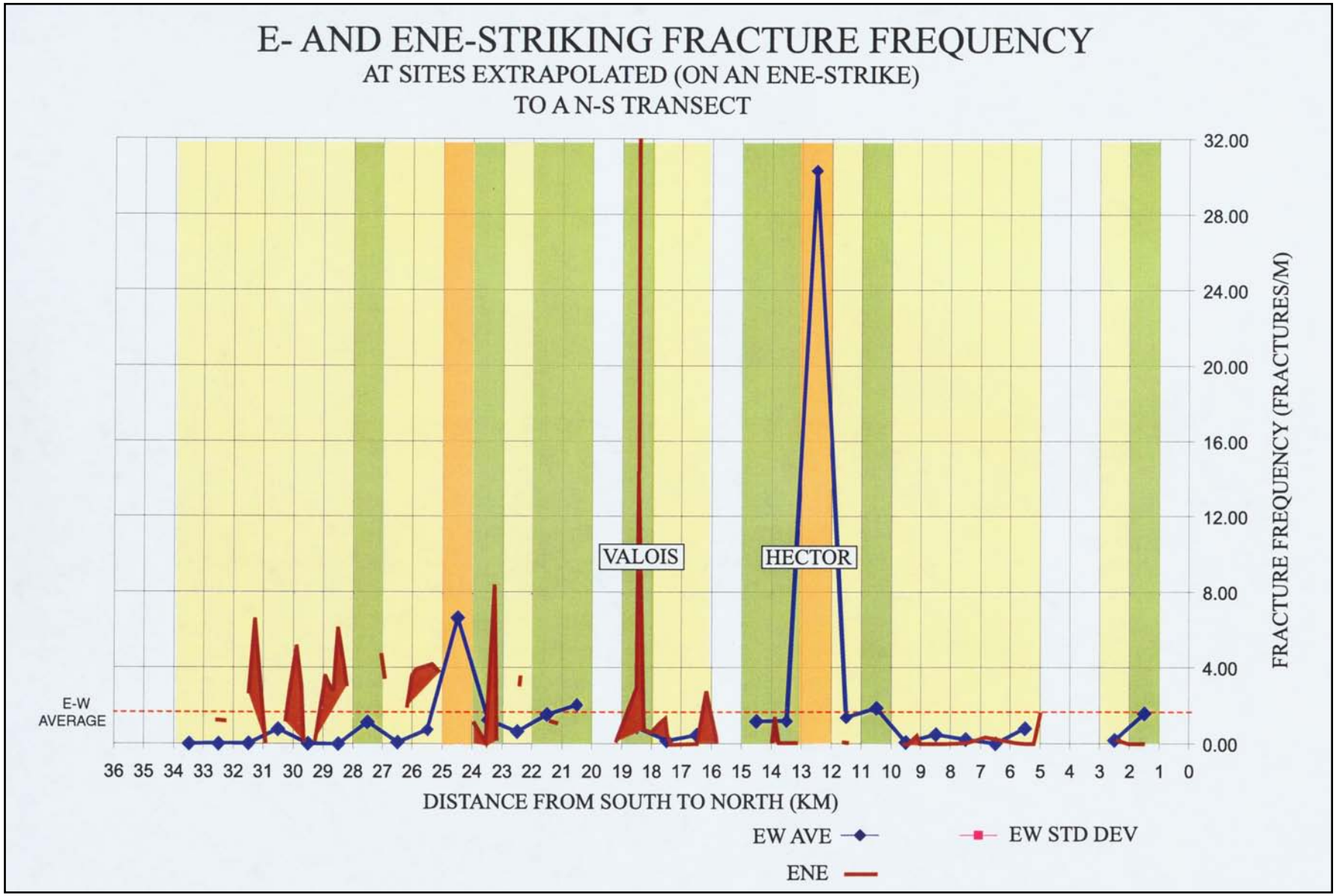

E- AND ENE-STRIKING FRACTURE FREQUENCY
AT SITES EXTRAPOLATED (ON AN ENE-STRIKE)
TO A N-S TRANSECT
32.00
28.00
24.00
20.00
16.00
12.00
8.00
4.00
0.00
FRACTURE FREQUENCY (FRACTURES/M)
VALOIS
HECTOR
E-W
AVERAGE
36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
DISTANCE FROM SOUTH TO NORTH (KM)
EW AVE
EW STD DEV
ENE

FIGURE 2.1-5

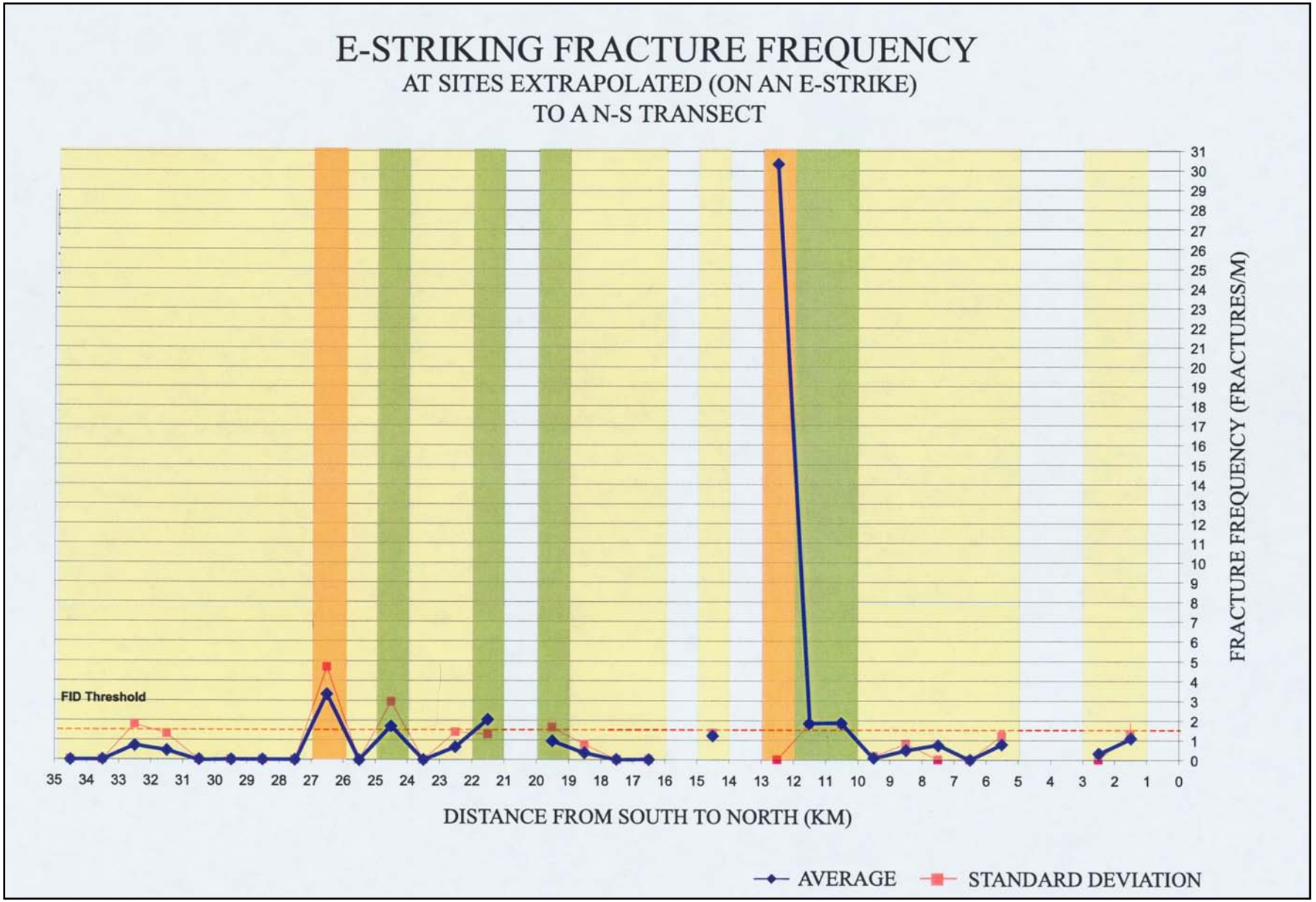

E-STRIKING FRACTURE FREQUENCY
AT SITES EXTRAPOLATED (ON AN E-STRIKE)
TO A N-S TRANSECT
FID Threshold
FRACTURE FREQUENCY (FRACTURES/M)
DISTANCE FROM SOUTH TO NORTH (KM)
AVERAGE
STANDARD DEVIATION

FIGURE 2.1-6

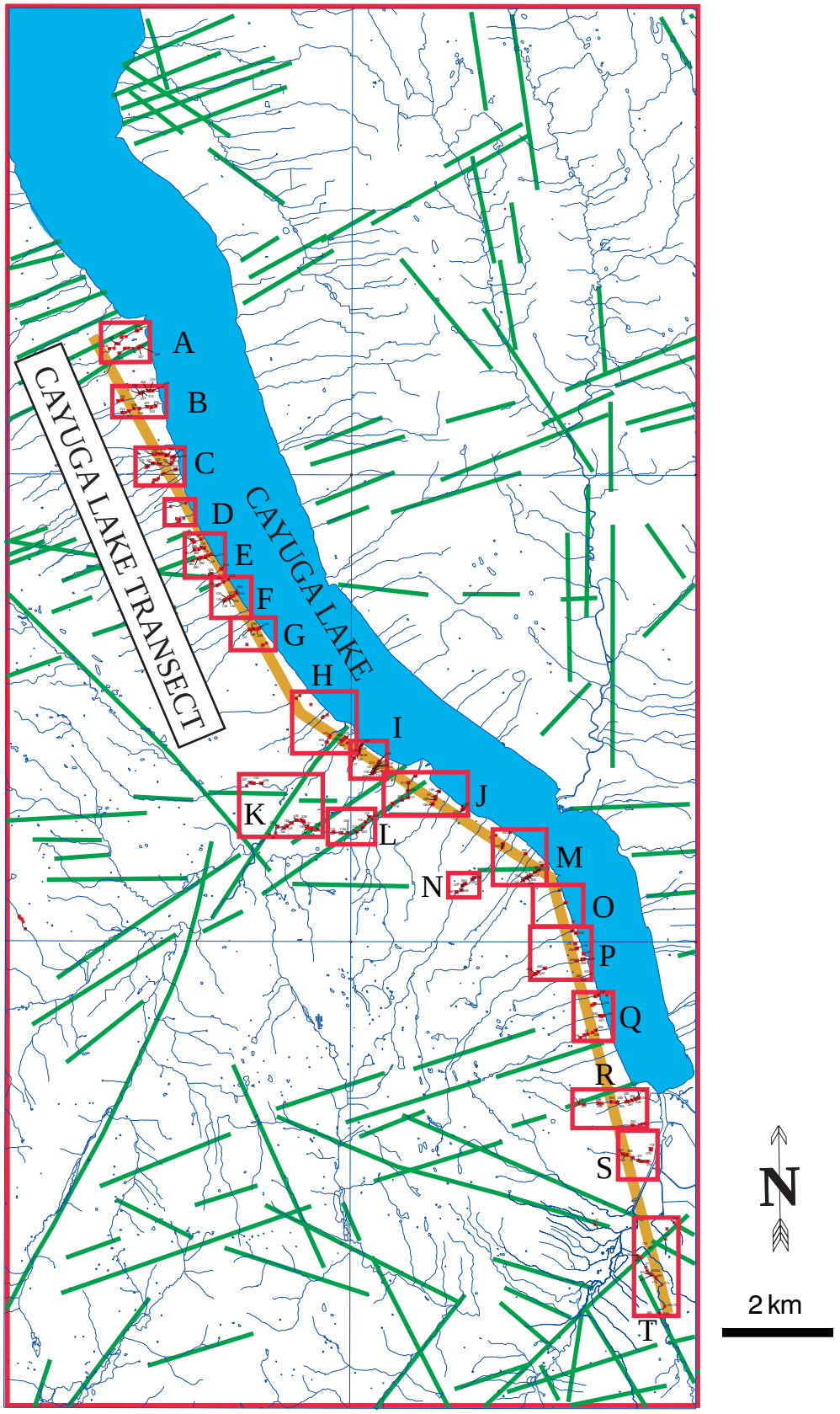

CAYUGA LAKE TRANSECT
CAYUGA LAKE
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
N
2 km

FIGURE 2.1-7

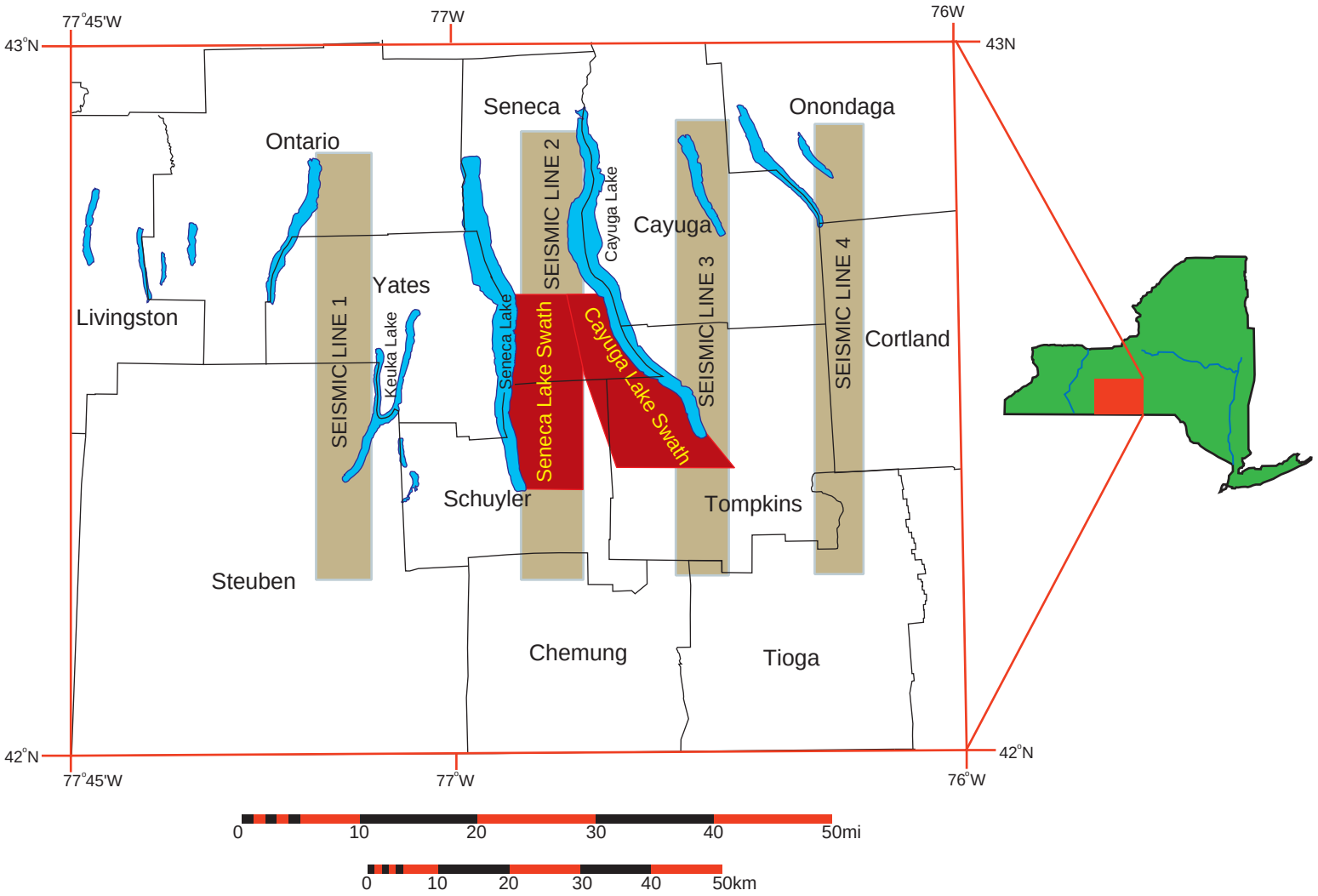

77°45'W
77W
76W
43°N
43N
Seneca
Onondaga
Ontario
SEISMIC LINE 2
Cayuga Lake
Cayuga
SEISMIC LINE 3
SEISMIC LINE 4
Yates
SEISMIC LINE 1
Keuka Lake
Seneca Lake
Seneca Lake Swath
Cayuga Lake Swath
Livingston
Cortland
Schuyler
Tompkins
Steuben
Chemung
Tioga
42°N
42°N
77°45'W
77°W
76°W
0 10 20 30 40 50mi
0 10 20 30 40 50km

FIGURE 2.4-1

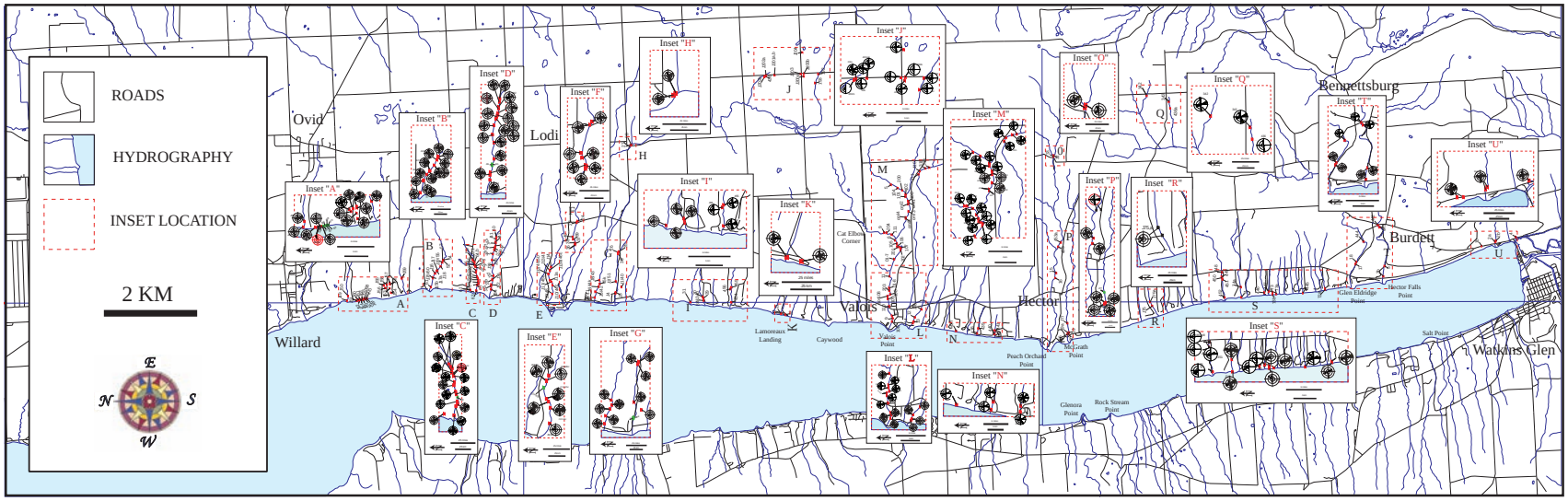
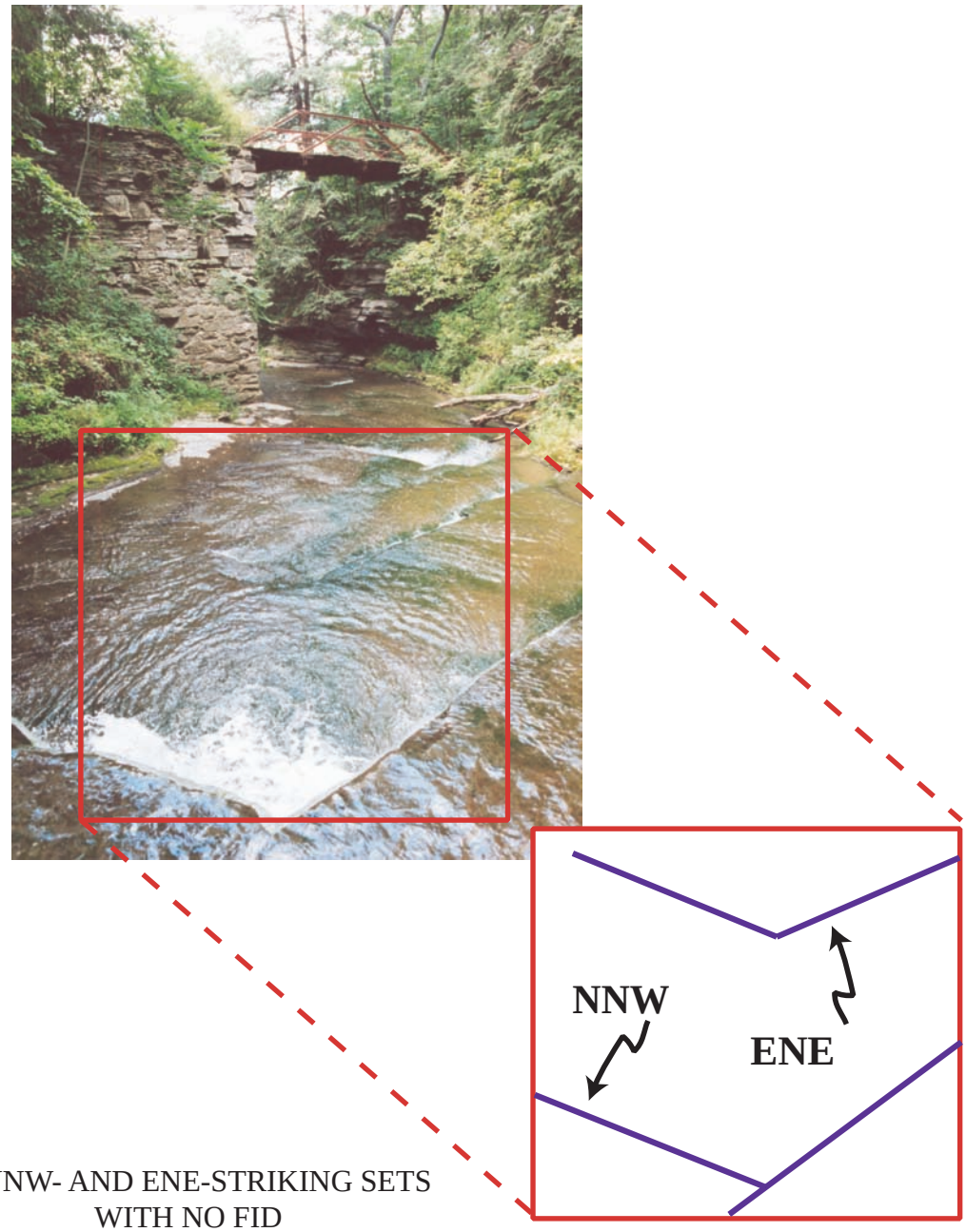

ROADS
HYDROGRAPHY
INSET LOCATION
2 KM
E
N
S
W
Ovid
Lodi
Willard
Watkins Glen
Burdett
Hector
Valois
Inset "A"
Inset "B"
Inset "C"
Inset "D"
Inset "E"
Inset "F"
Inset "G"
Inset "H"
Inset "I"
Inset "J"
Inset "K"
Inset "L"
Inset "M"
Inset "N"
Inset "O"
Inset "P"
Inset "Q"
Inset "R"
Inset "S"
Inset "T"
Inset "U"

FIGURE 3.1-1



NNW- AND ENE-STRIKING SETS
WITH NO FID
MIDDLE ROAD

FIGURE 3.1-2

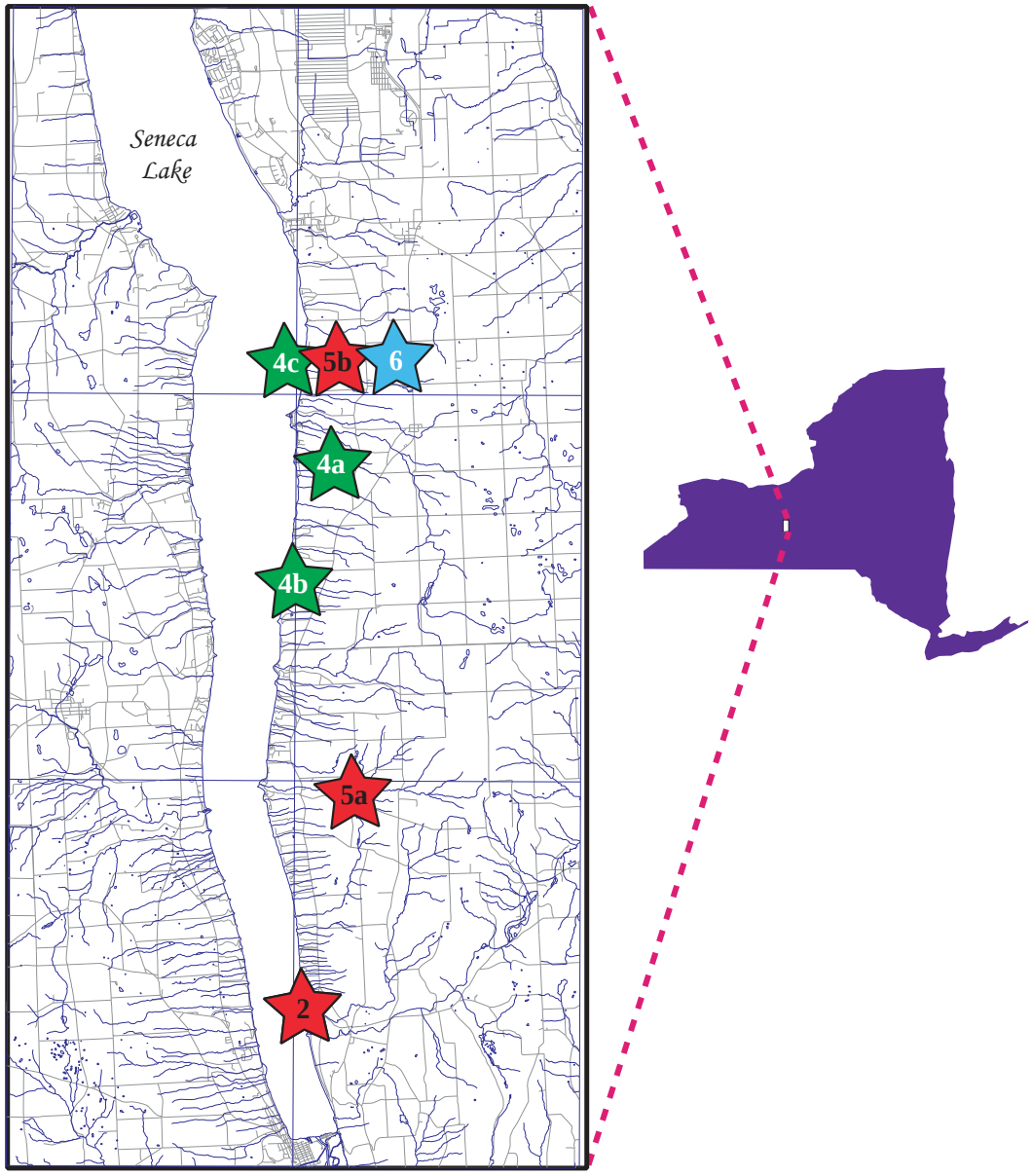


FIGURE 3.1-3

3.1-4a. ENE-STRIKING FID

3.1-4b. ENE-STRIKING FID

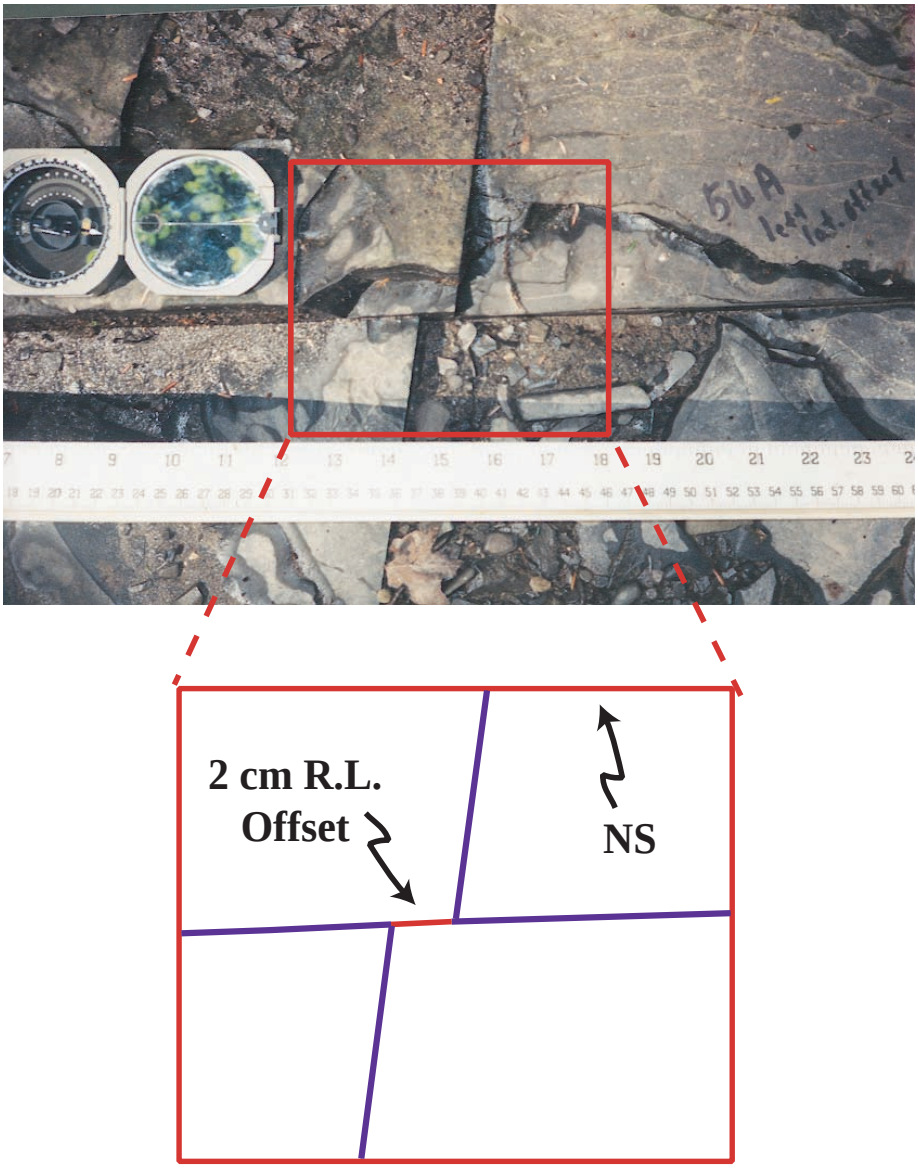
3.1-4c. ENE-STRIKING FID

FIGURE 3.1-4

3.1-5a. NNW-STRIKING FID

3.1-5b. NNW-STRIKING FID
SIXTEEN FALLS CREEK

FIGURE 3.1-5



N-STRKING FRACTURE
WITH DEXTRAL MOTION
SIXTEEN FALLS CREEK

FIGURE 3.1-6

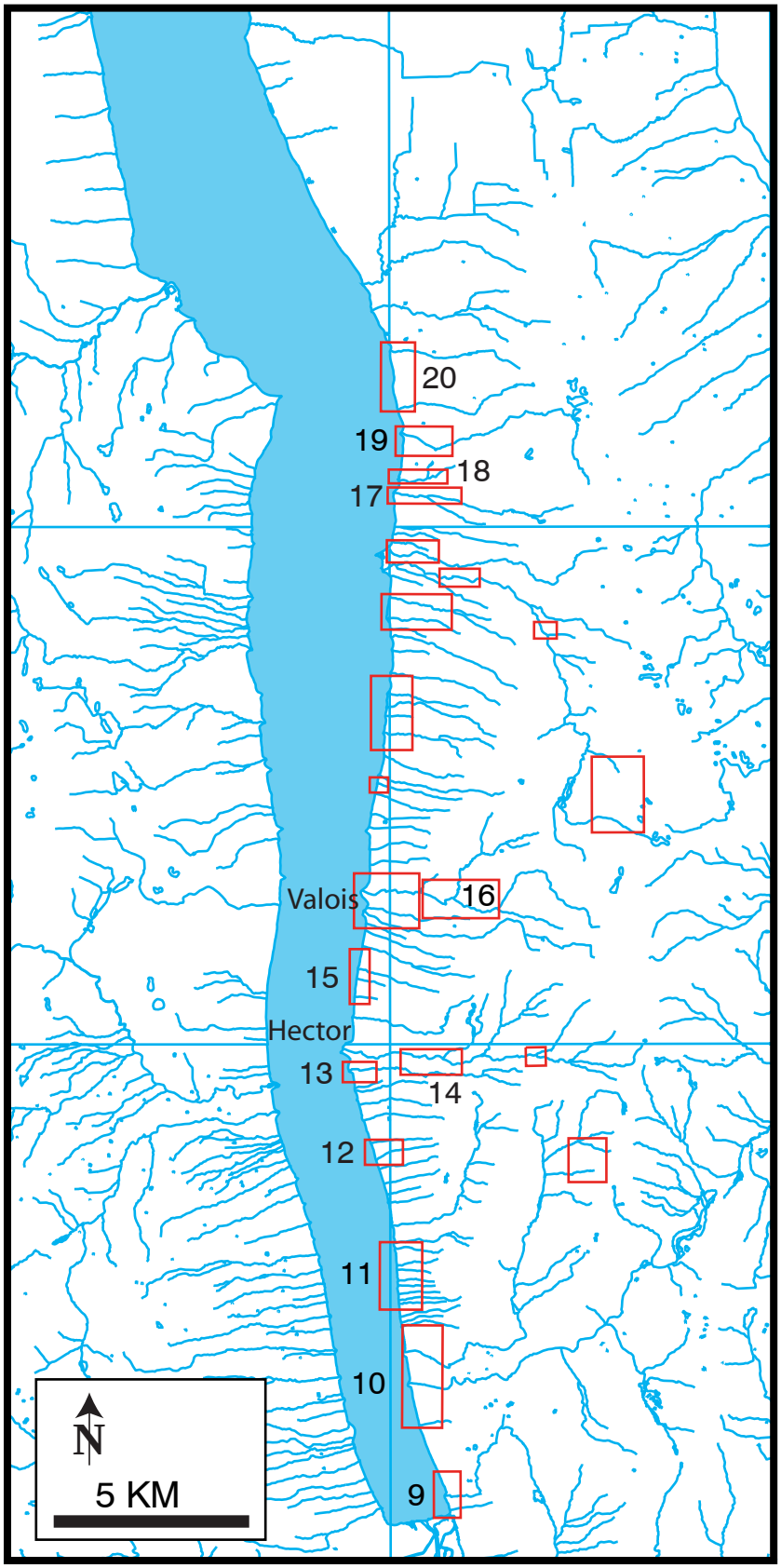


FIGURE 3.1-7

E- AND ENE-STRIKING FRACTURE FREQUENCY

AT SITES EXTRAPOLATED TO A N-S TRANSECT

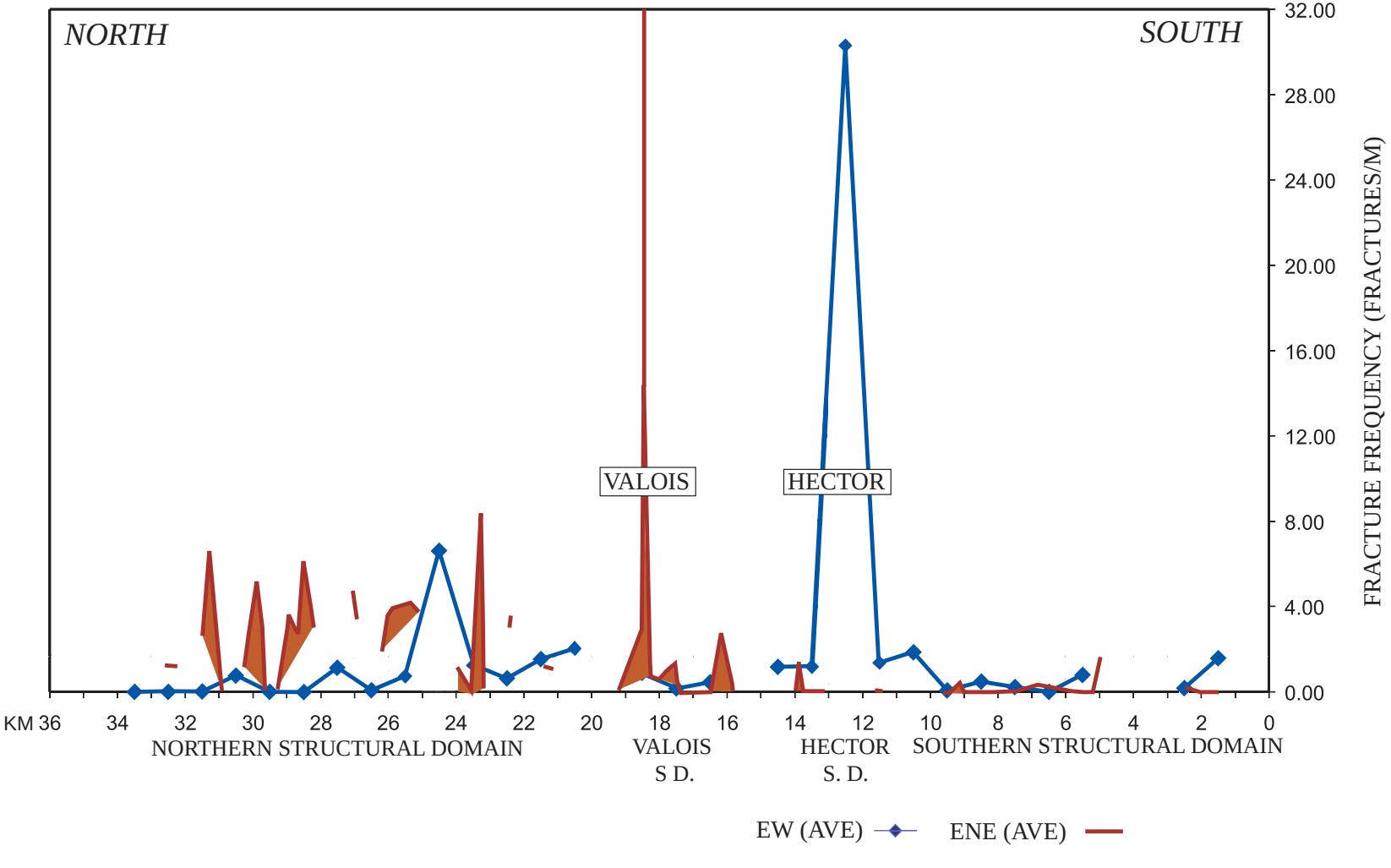


FIGURE 3.1-8

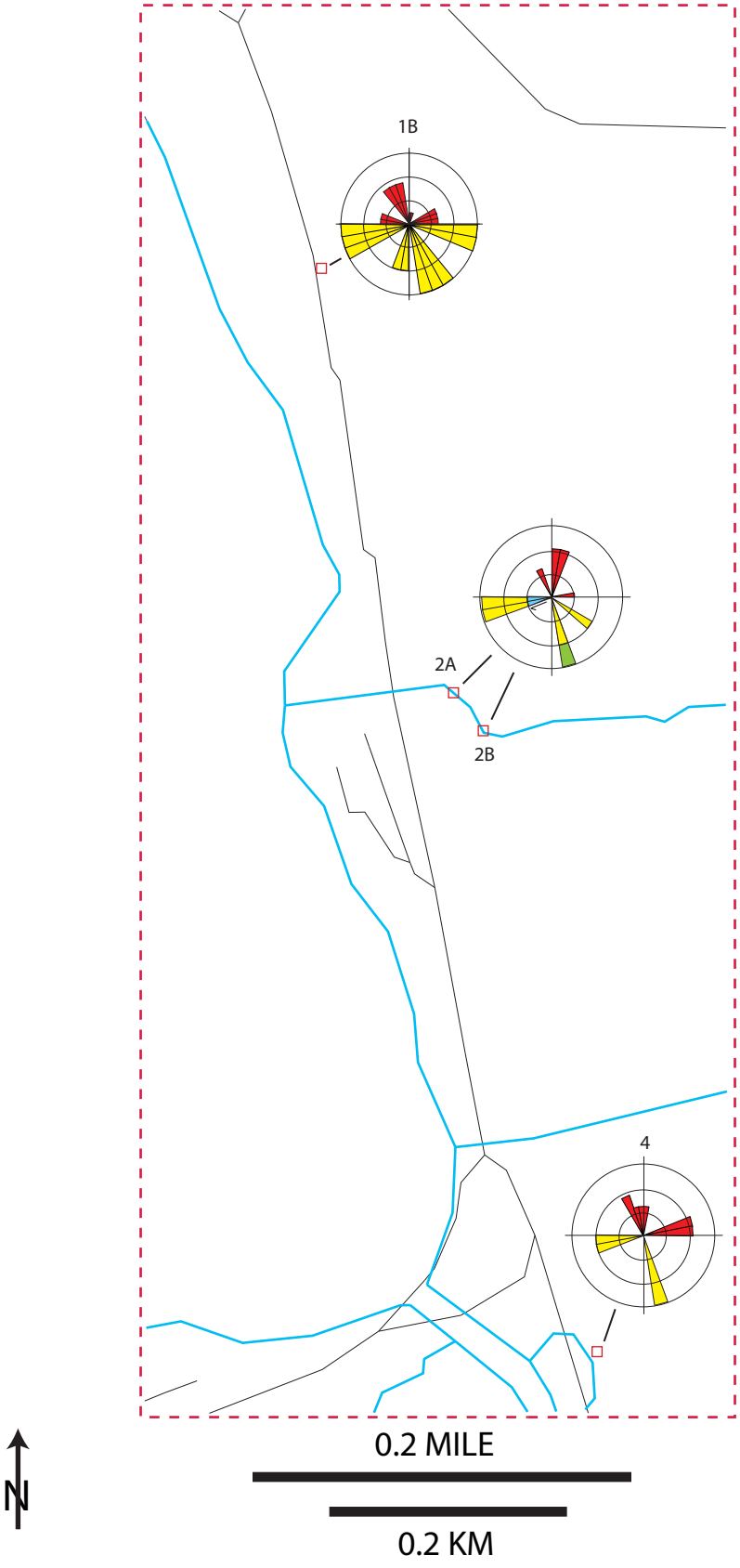


FIGURE 3.1-9

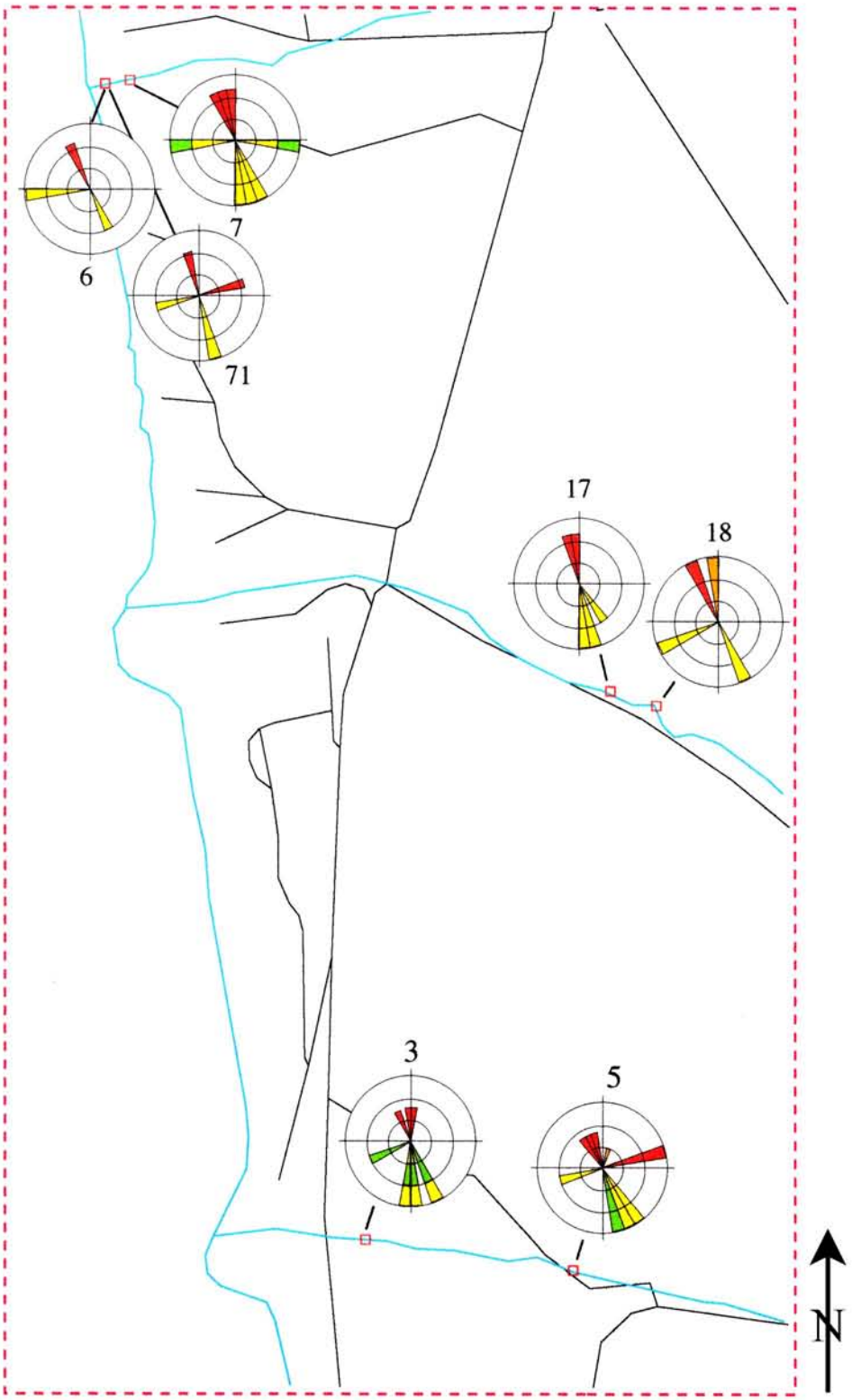


FIGURE 3.1-10

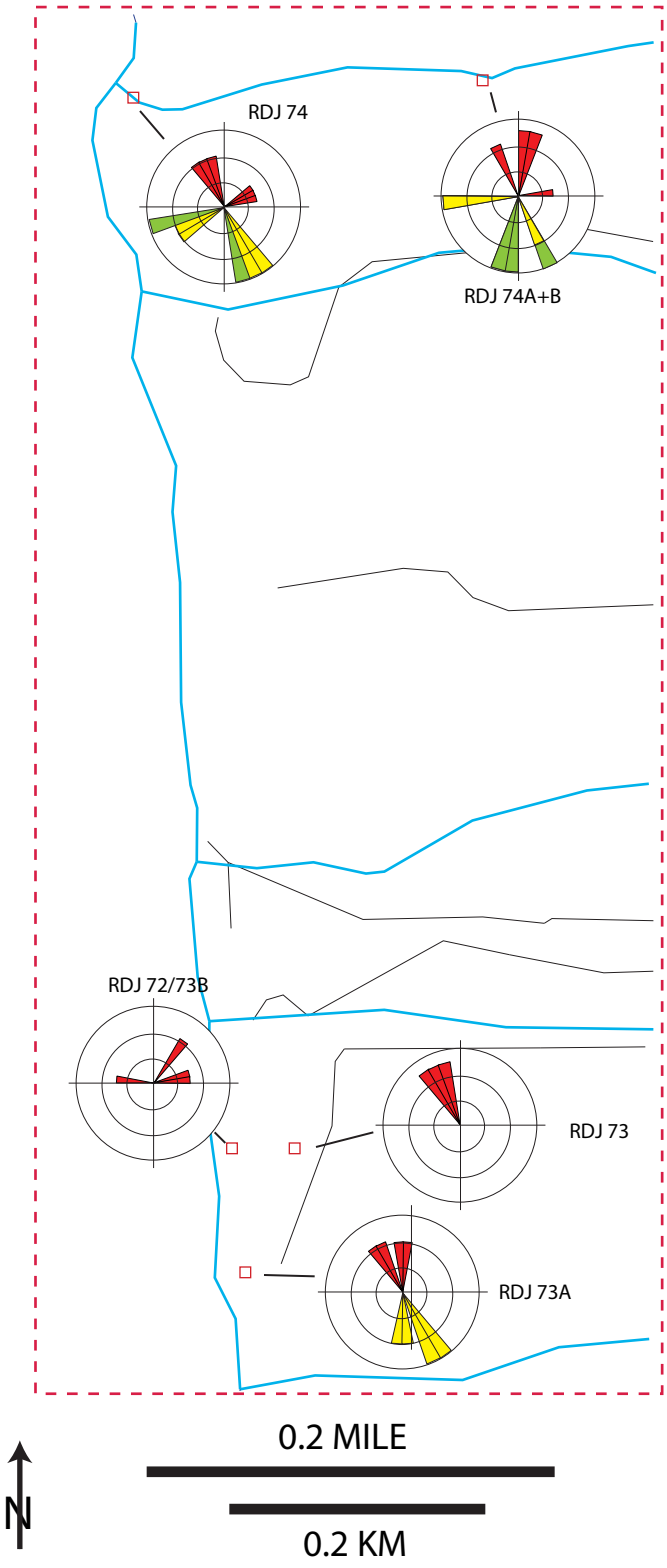


FIGURE 3.1-11

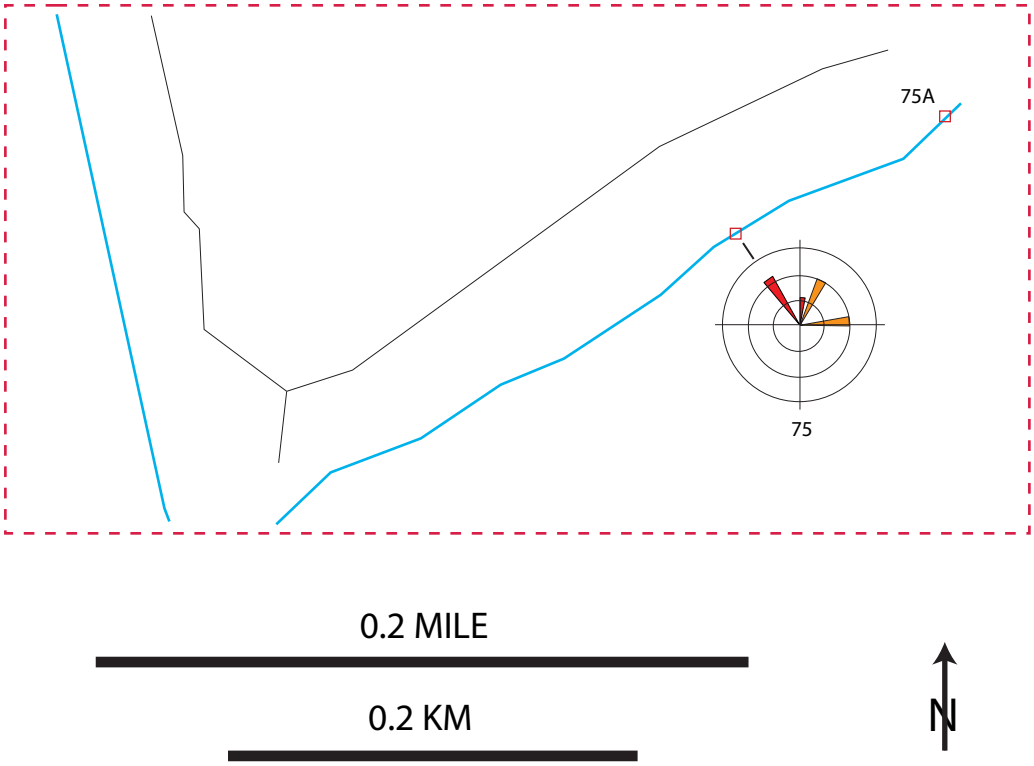


FIGURE 3.1-12

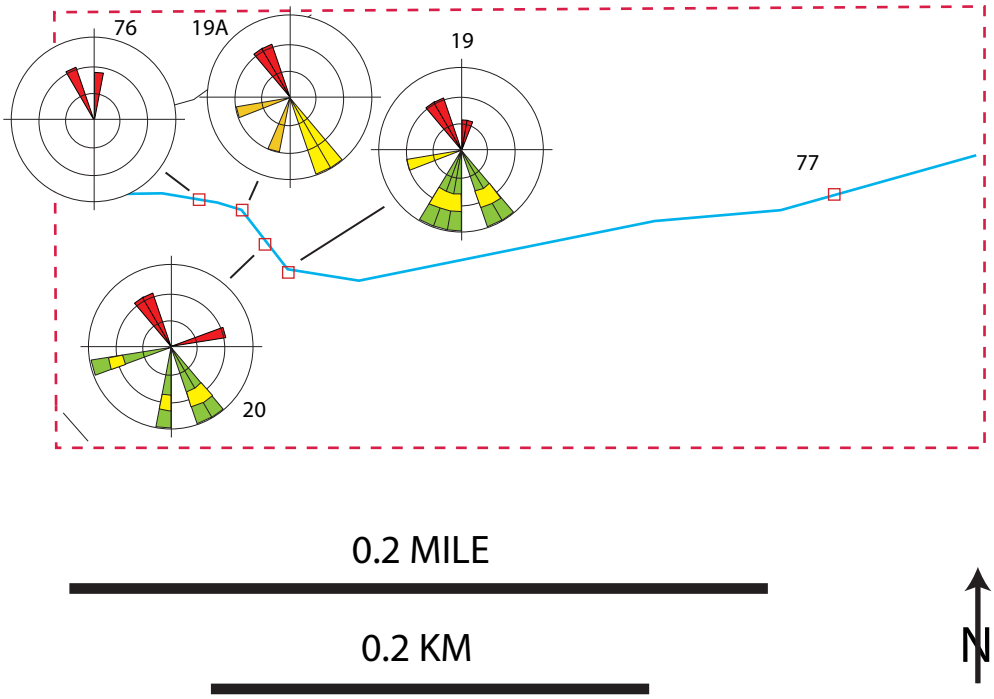


FIGURE 3.1-13

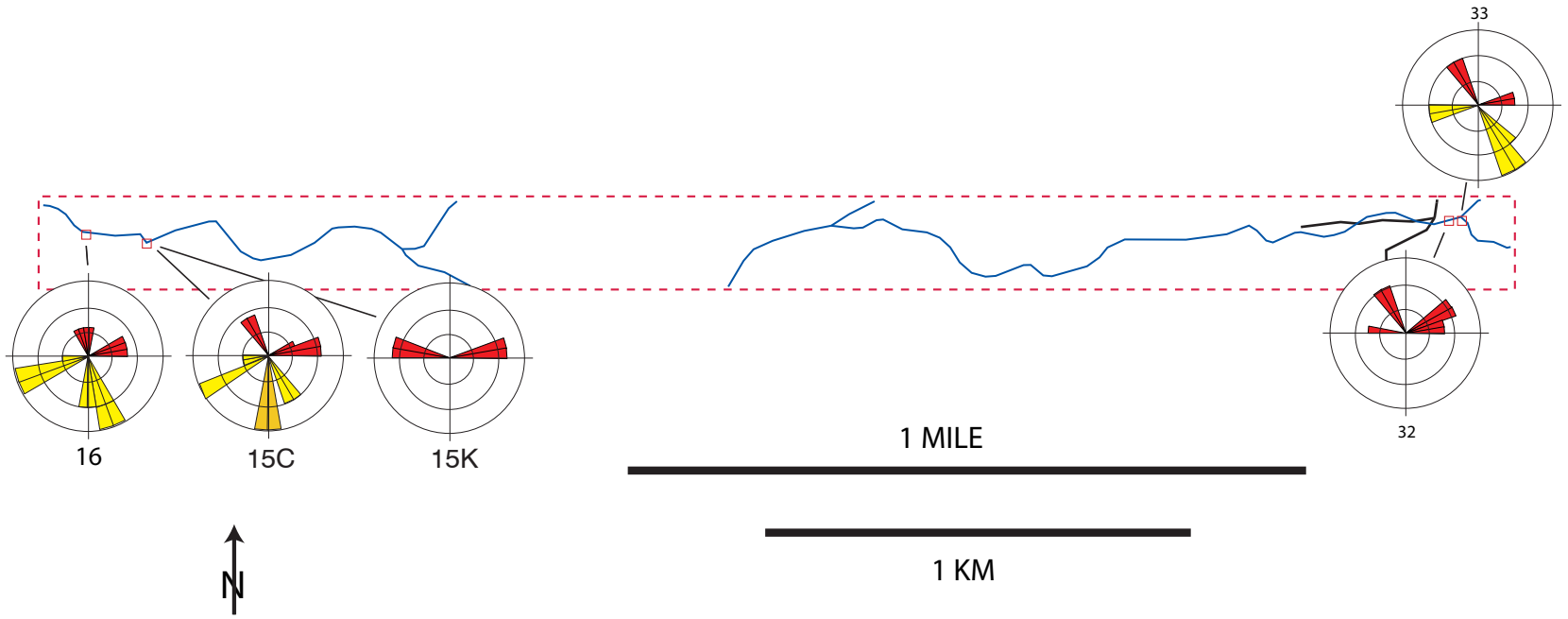


FIGURE 3.1-14

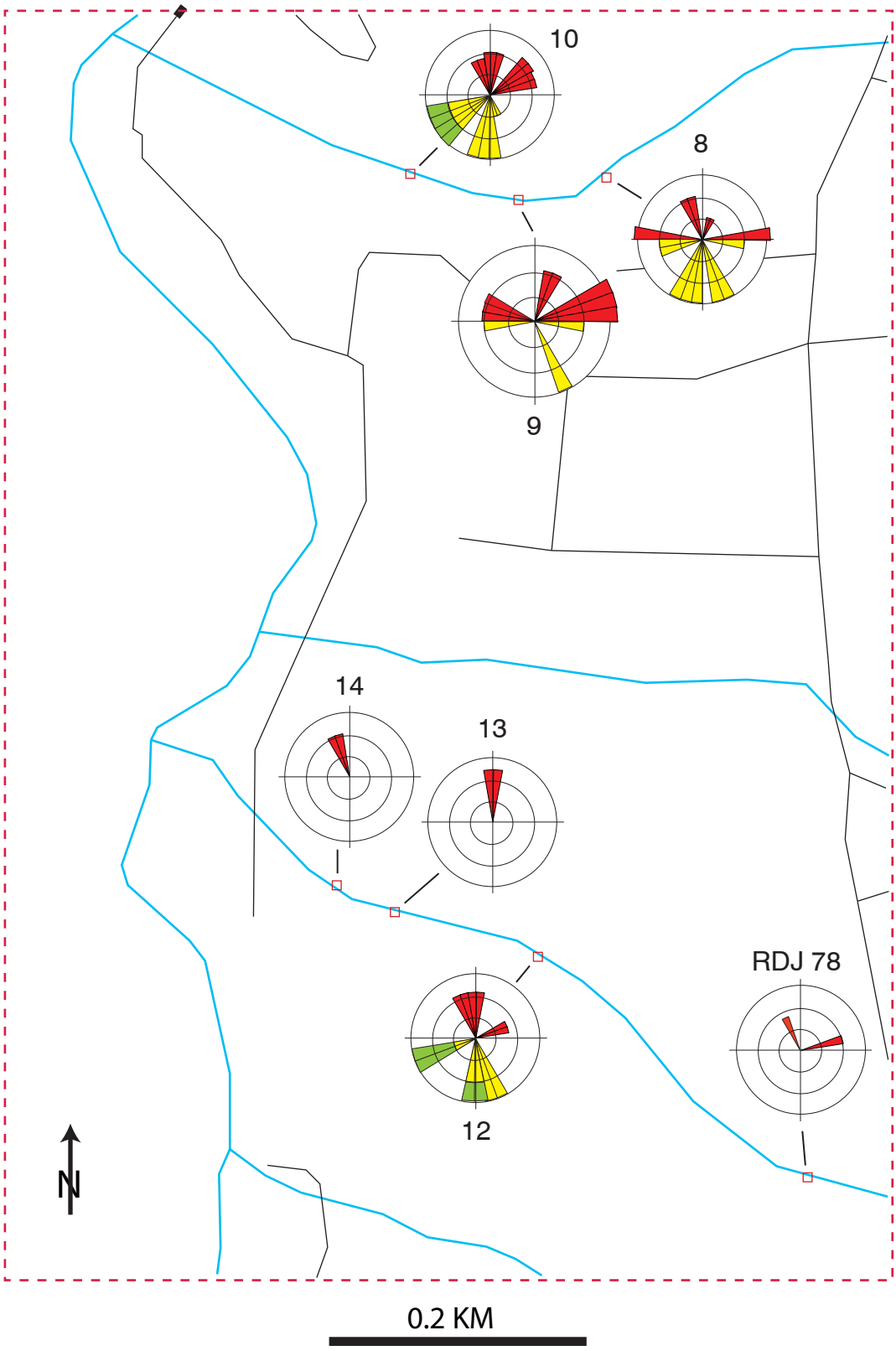


FIGURE 3.1-15

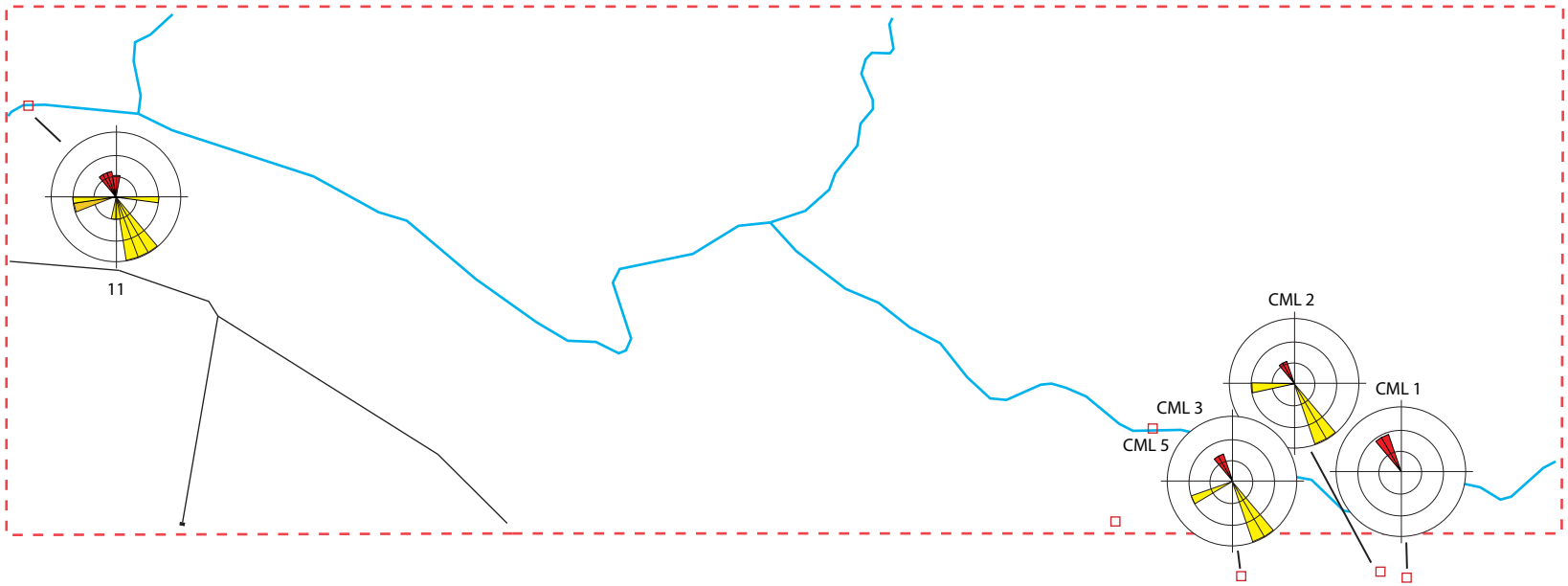


FIGURE 3.1-16

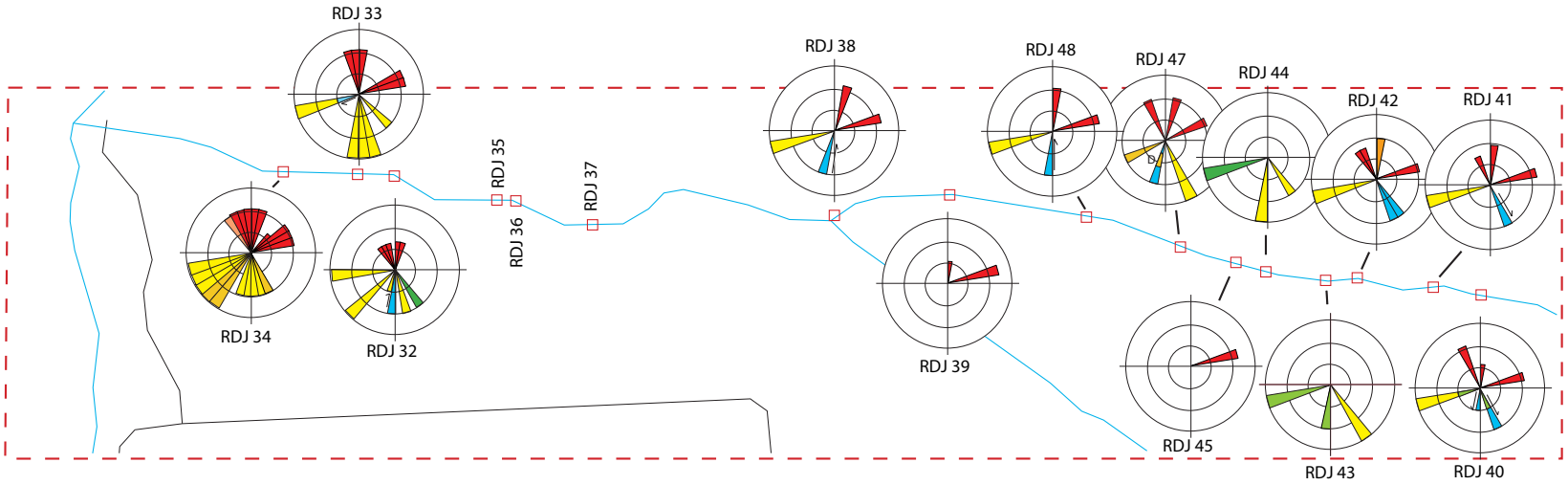

RDJ 33
RDJ 38
RDJ 48
RDJ 47
RDJ 44
RDJ 42
RDJ 41
RDJ 35
RDJ 37
RDJ 36
RDJ 34
RDJ 32
RDJ 39
RDJ 45
RDJ 43
RDJ 40
N
0.2 MILE
0.2 KM

FIGURE 3.1-17

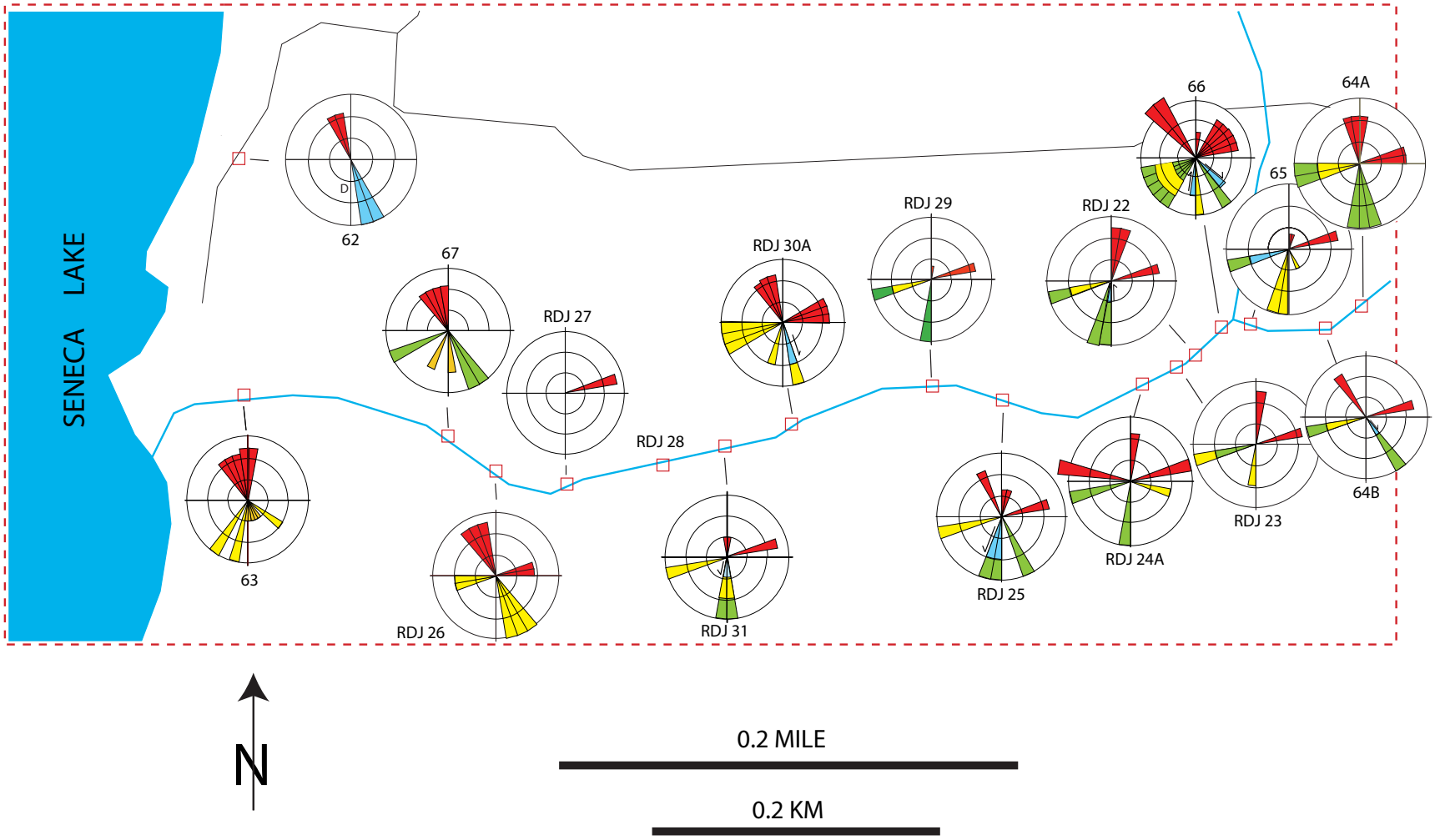

SENECA LAKE
62
D
67
RDJ 27
63
RDJ 26
RDJ 28
RDJ 31
RDJ 30A
RDJ 29
RDJ 22
66
64A
65
64B
RDJ 23
RDJ 24A
RDJ 25
N
0.2 MILE
0.2 KM

FIGURE 3.1-18

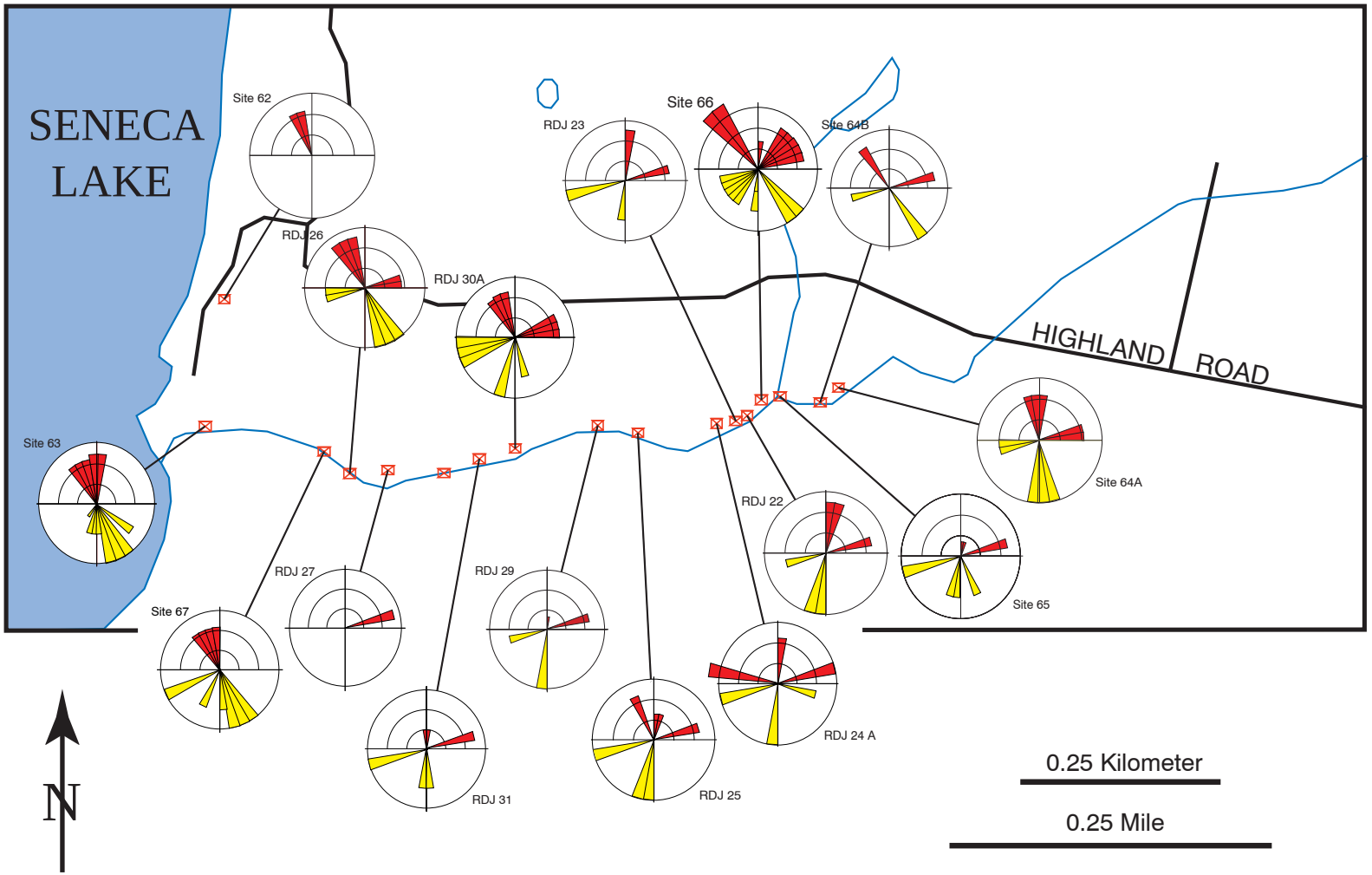

SENECA
LAKE
Site 62
RDJ 23
Site 66
Site 64B
RDJ 26
RDJ 30A
HIGHLAND
ROAD
Site 63
Site 64A
RDJ 22
RDJ 27
RDJ 29
Site 67
Site 65
RDJ 24 A
RDJ 31
RDJ 25
N
0.25 Kilometer
0.25 Mile

FIGURE 3.1-19

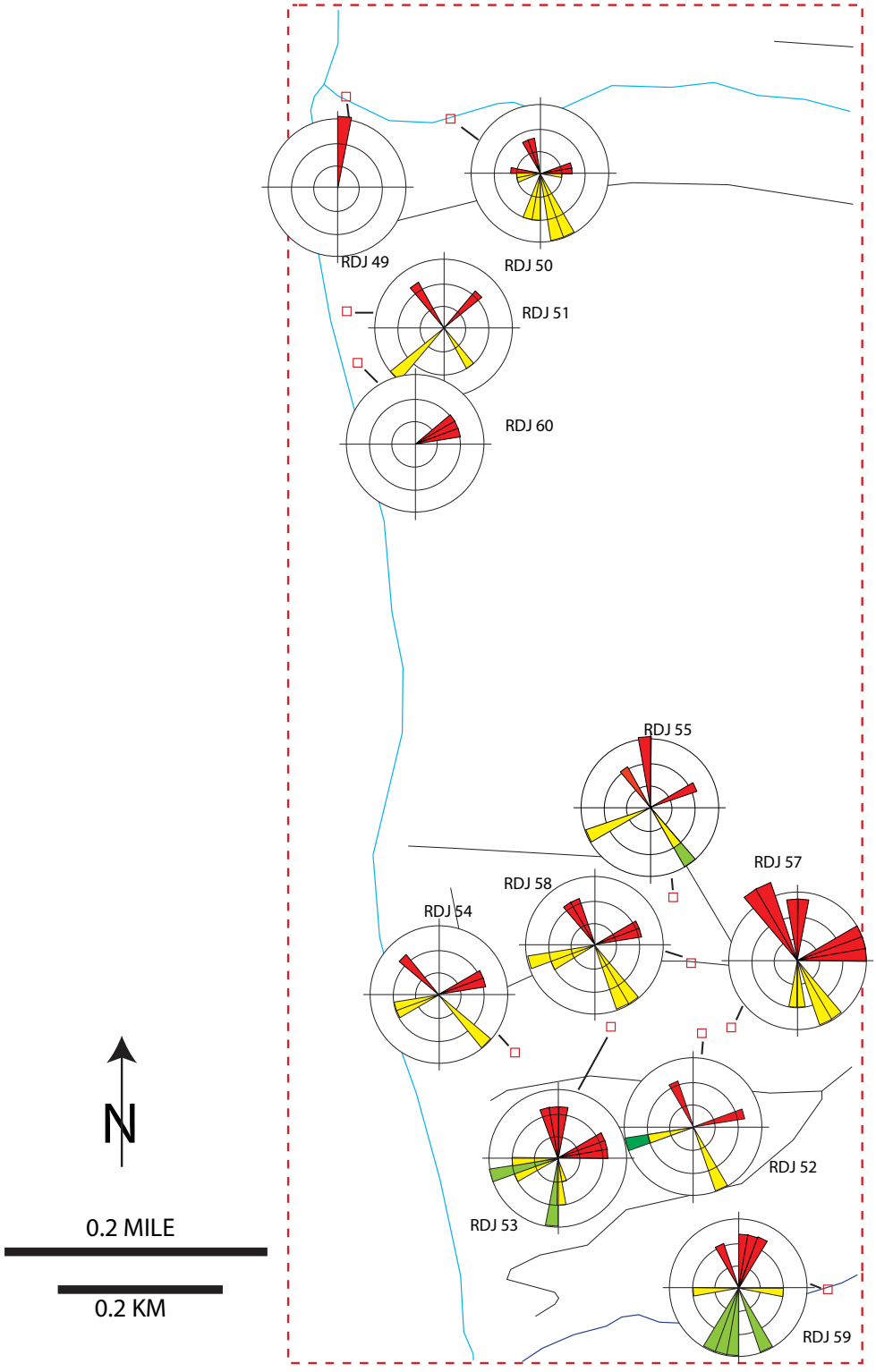

RDJ 49
RDJ 50
RDJ 51
RDJ 60
RDJ 55
RDJ 57
RDJ 58
RDJ 54
RDJ 52
RDJ 53
RDJ 59
N
0.2 MILE
0.2 KM

FIGURE 3.1-20

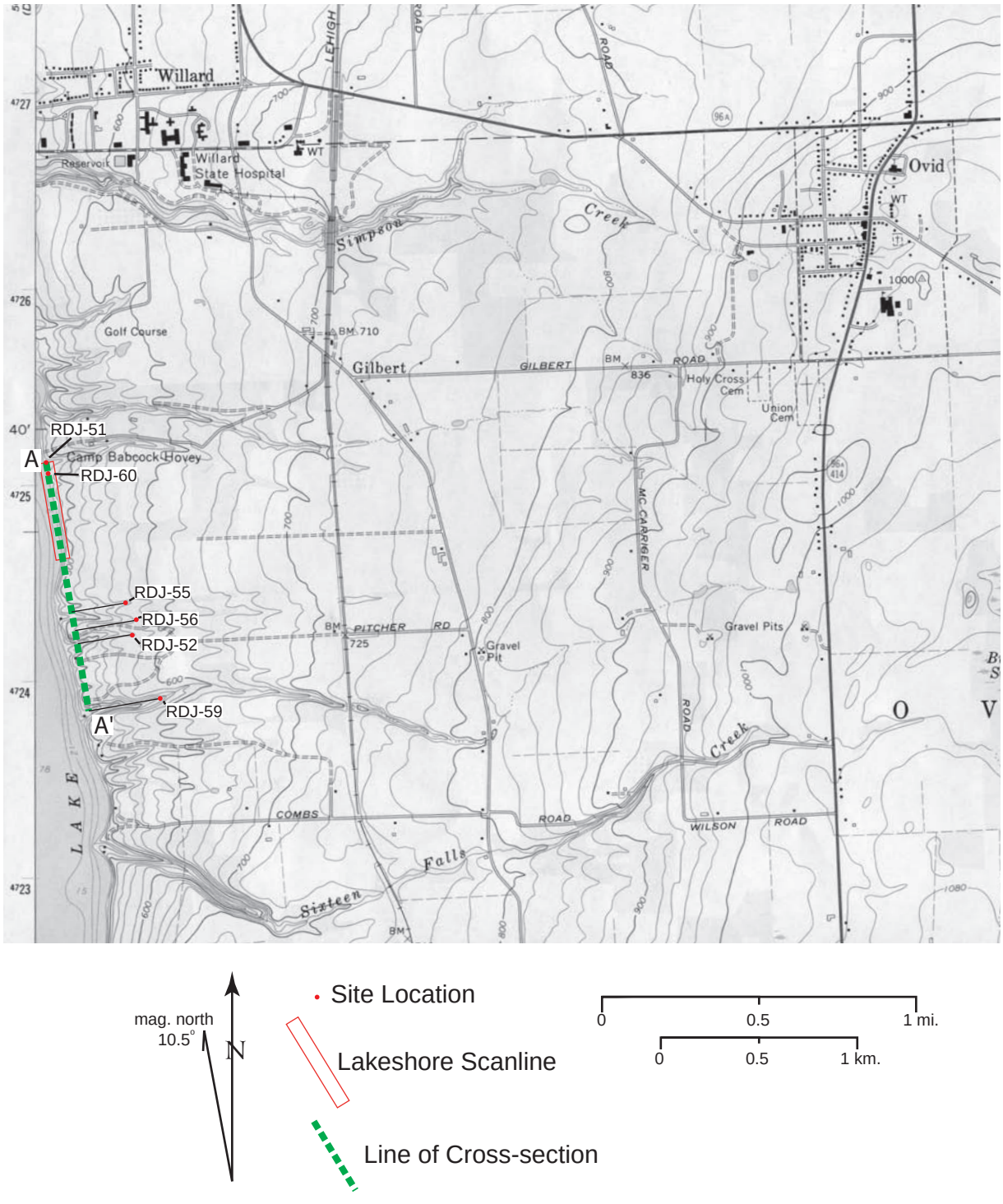

Willard
LEHIGH
ROAD
Reservoir
Willard
State Hospital
WT
Ovid
Simpson
Creek
Golf Course
BM 710
Gilbert
GILBERT
ROAD
BM
836
Holy Cross
Cem
Union
Cem
RDJ-51
A
Camp Babcock Hovey
RDJ-60
RDJ-55
RDJ-56
RDJ-52
RDJ-59
A'
PITCHER
RD
BM
725
Gravel
Pit
Gravel Pits
MC CARRIGER
ROAD
Creek
COMBS
ROAD
WILSON
ROAD
Falls
Sixteen
LAKE
mag. north
10.5°
N
Site Location
Lakeshore Scanline
Line of Cross-section
0
0.5
1 mi.
0
0.5
1 km.

FIGURE 3.1-21

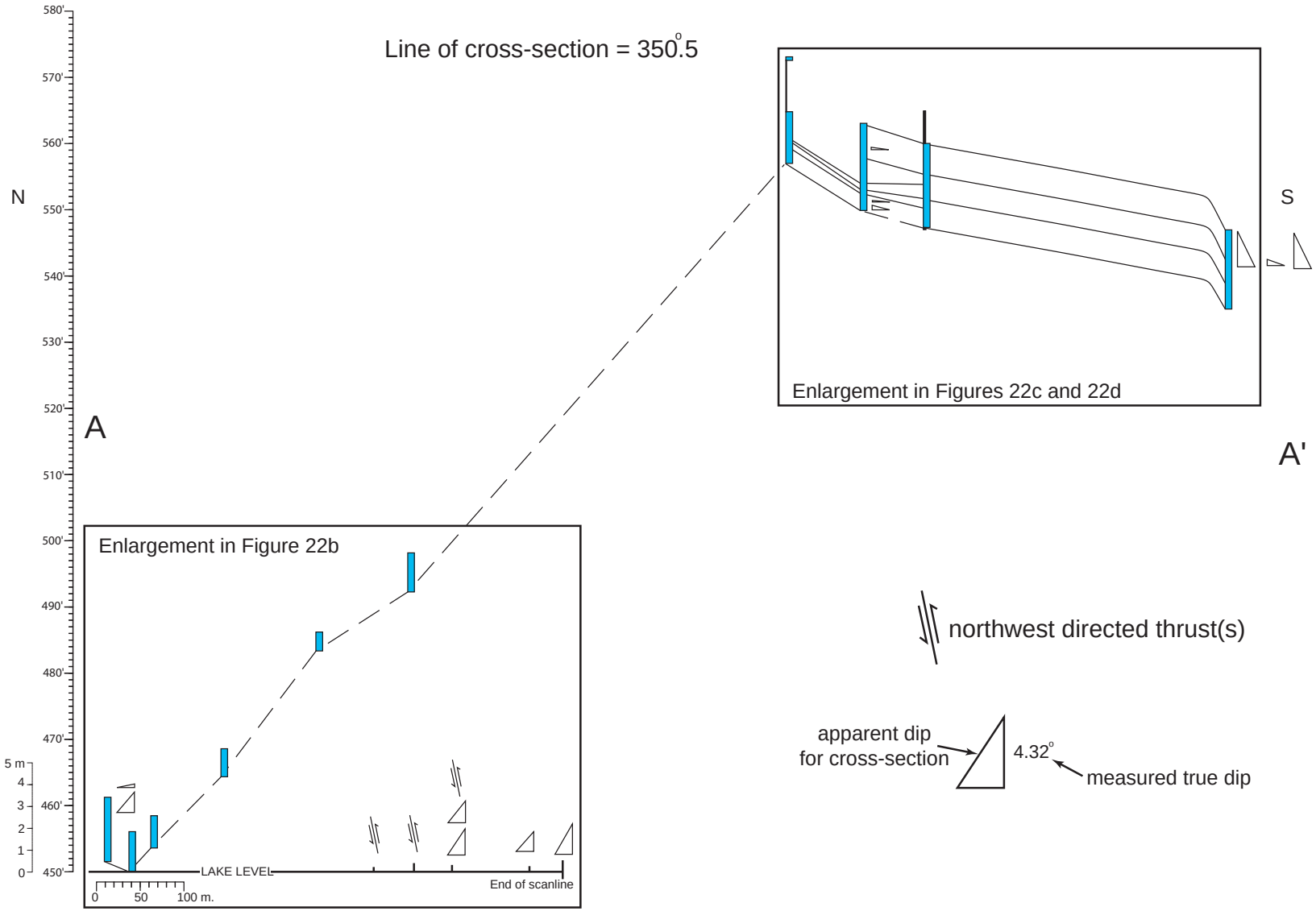


FIGURE 3.1-22a

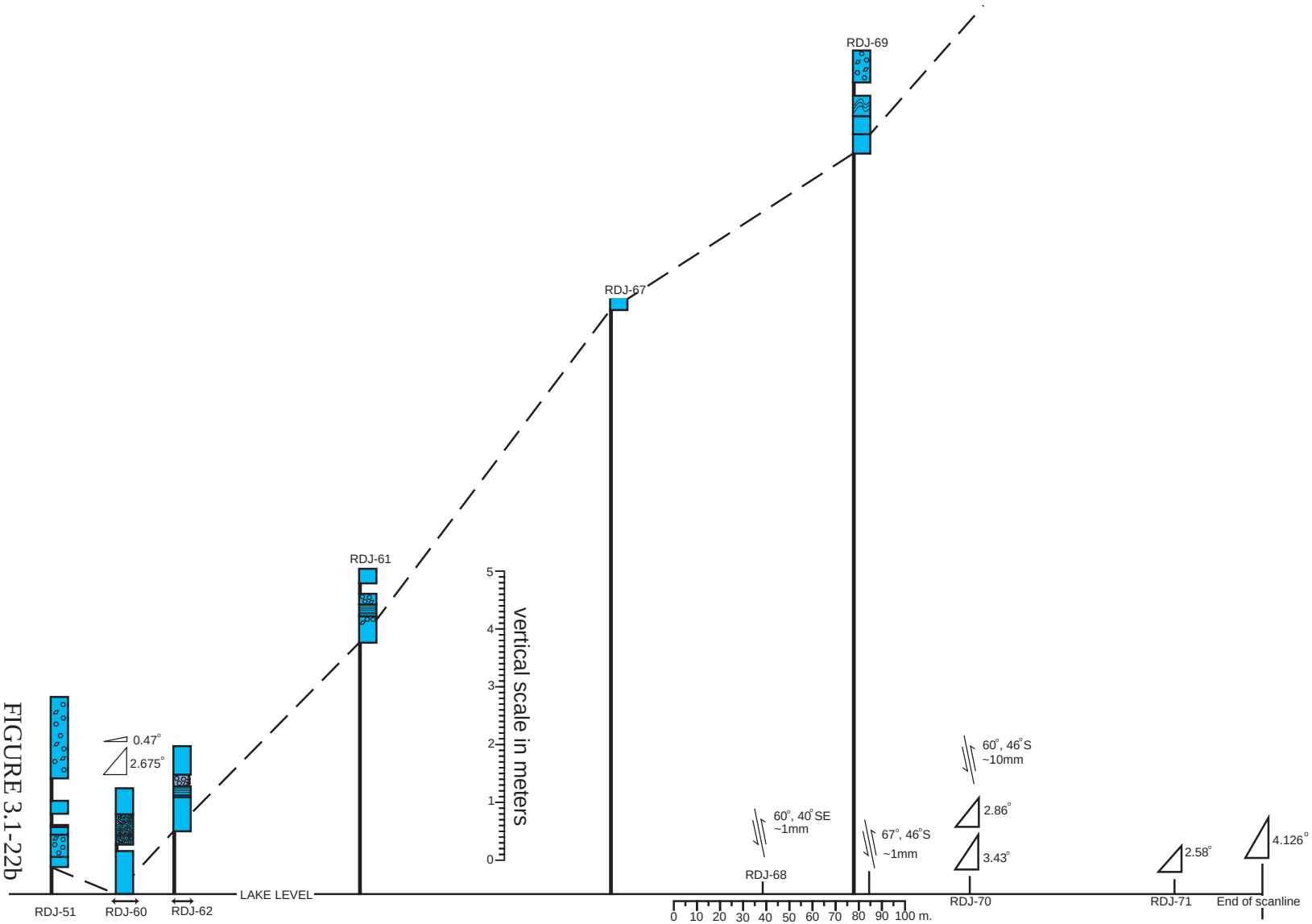


FIGURE 3.1-22b

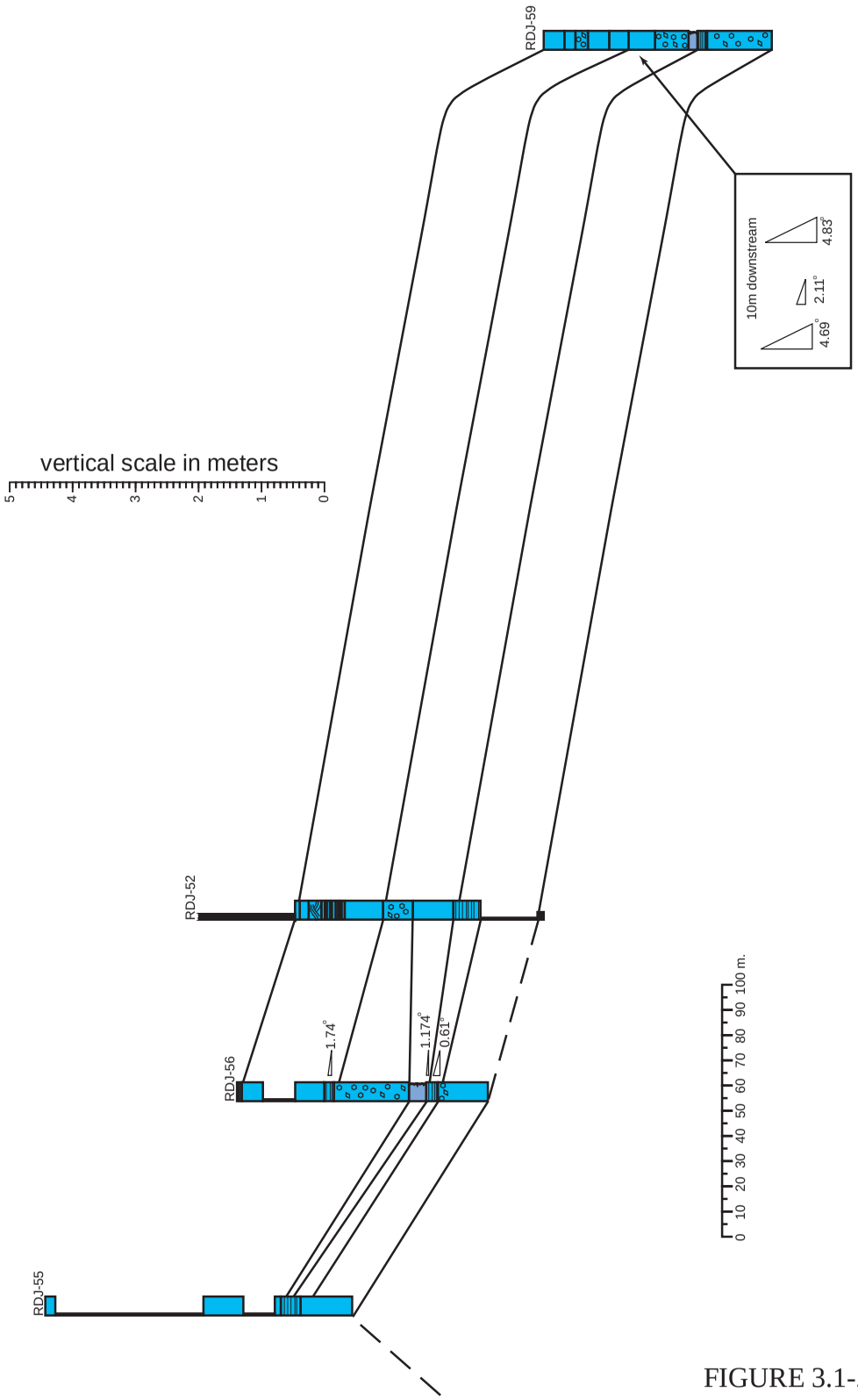


FIGURE 3.1-22C

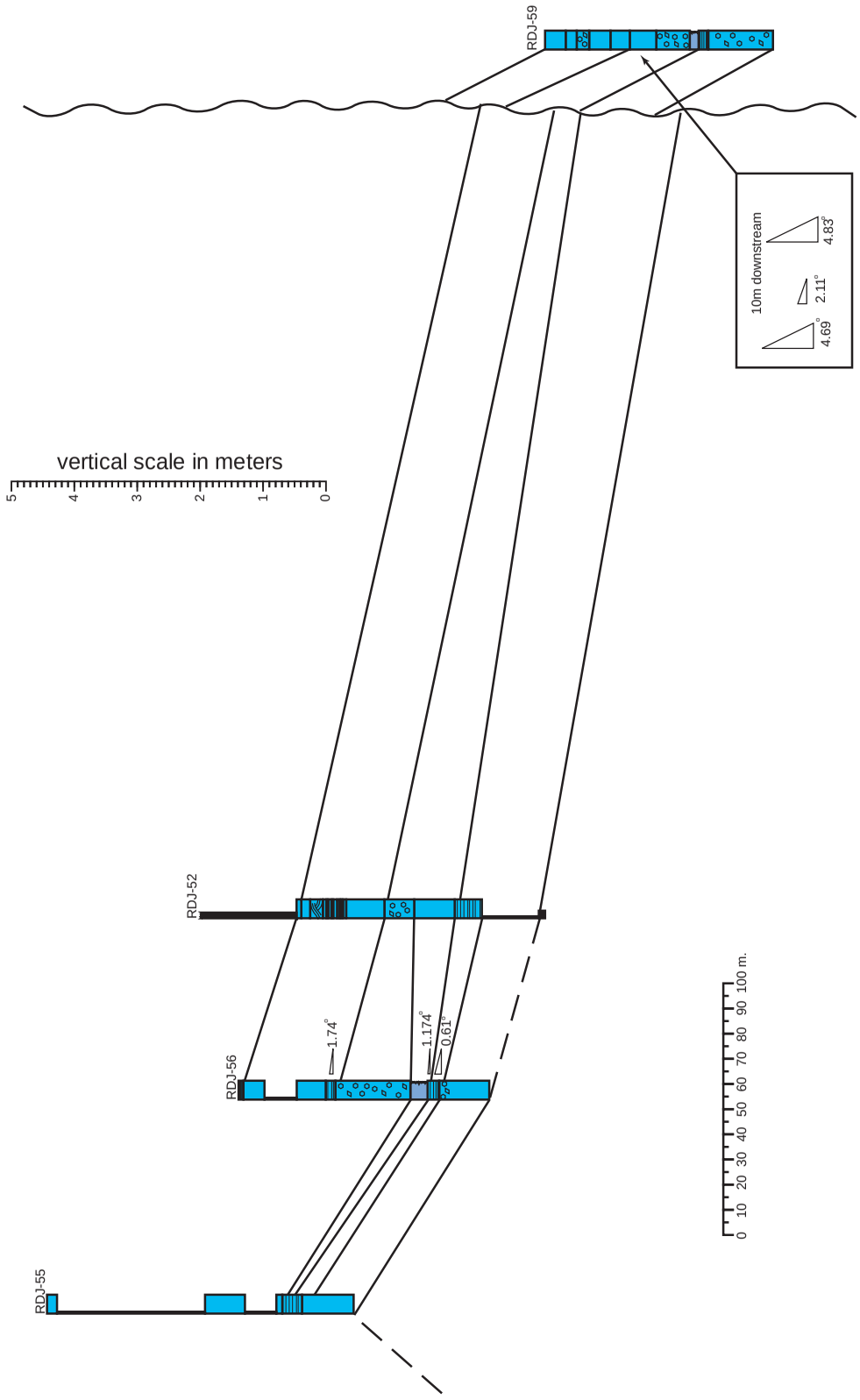


FIGURE 3.1-22d

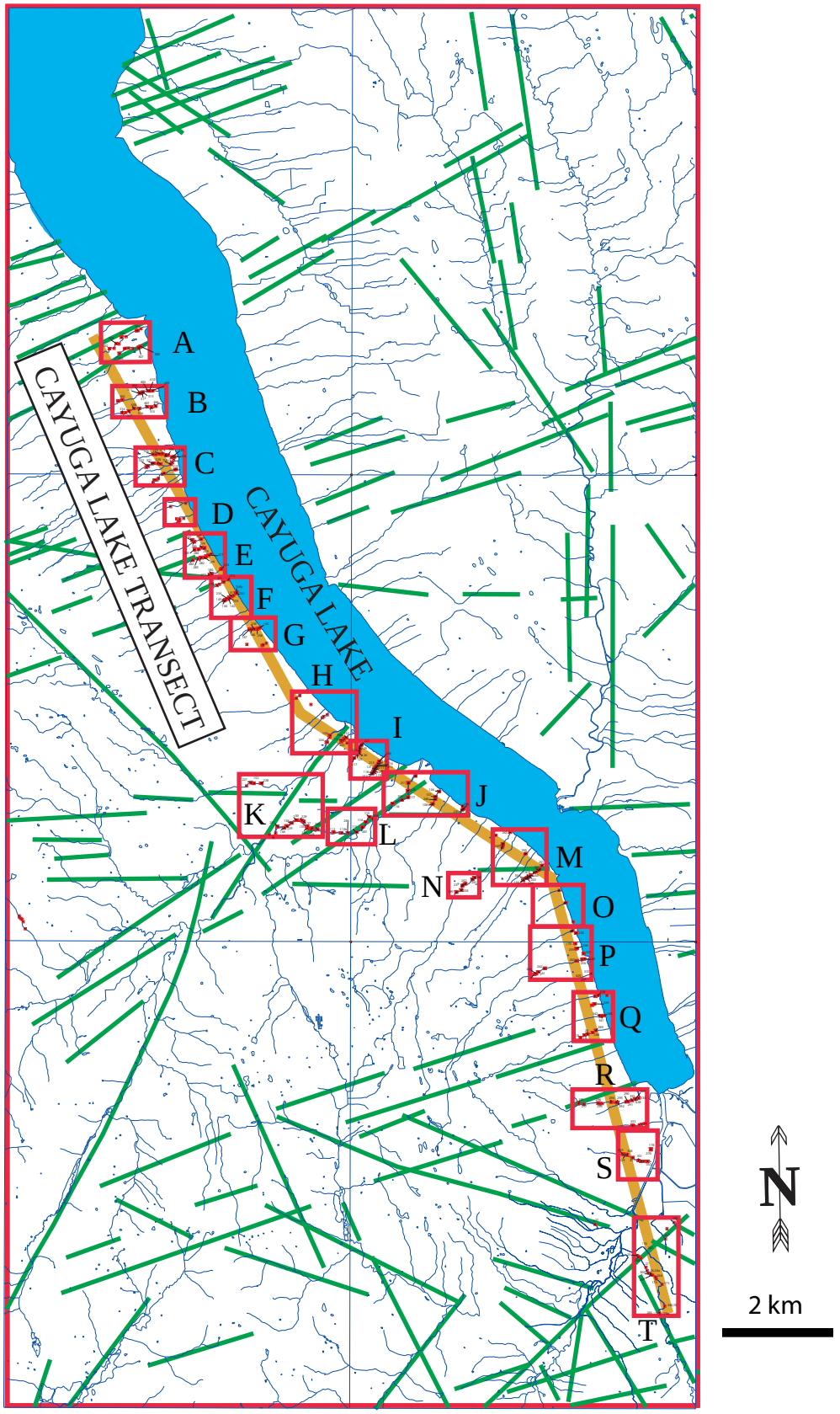

CAYUGA LAKE TRANSECT
CAYUGA LAKE
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
N
2 km

FIGURE 3.1-23

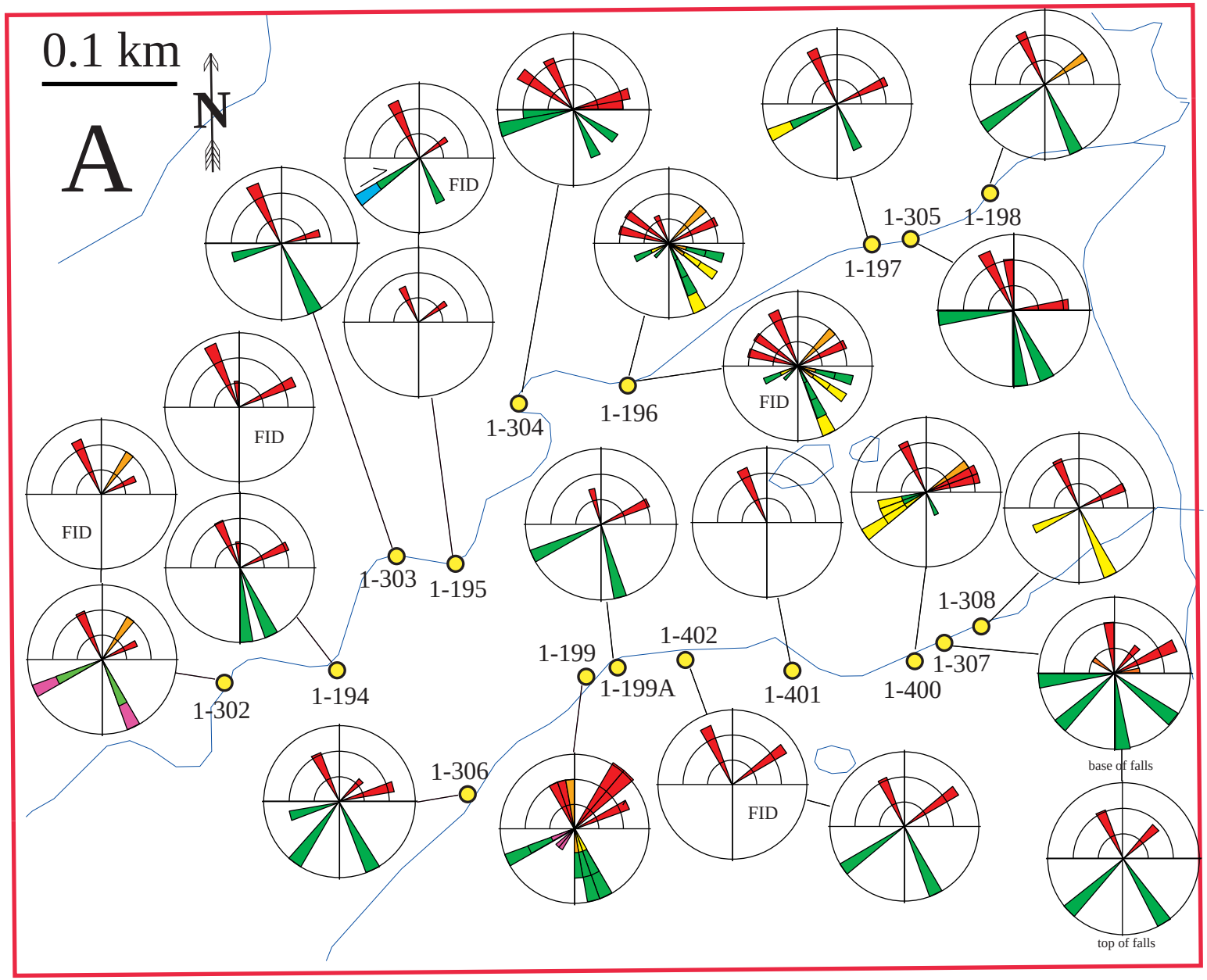

0.1 km
A
N
FID
1-304
1-196
1-305
1-198
1-197
FID
FID
FID
1-303
1-195
1-308
1-199
1-402
1-199A
1-307
1-400
1-401
1-302
1-194
1-306
FID
base of falls
top of falls

FIGURE 3.1-24

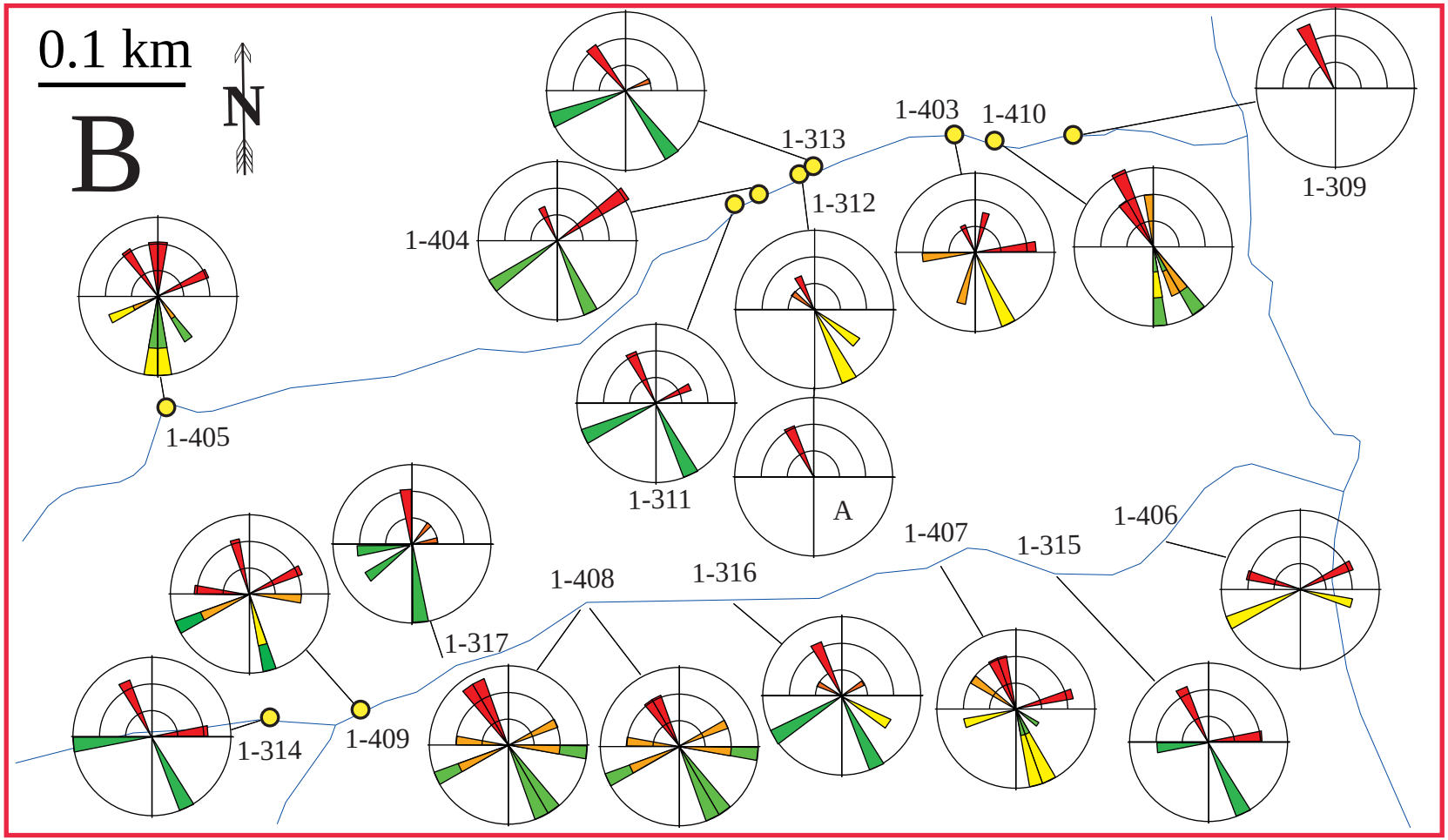

0.1 km
B
N
1-313
1-403
1-410
1-309
1-312
1-404
1-405
1-311
A
1-406
1-407
1-315
1-408
1-316
1-317
1-314
1-409

FIGURE 3.1-25

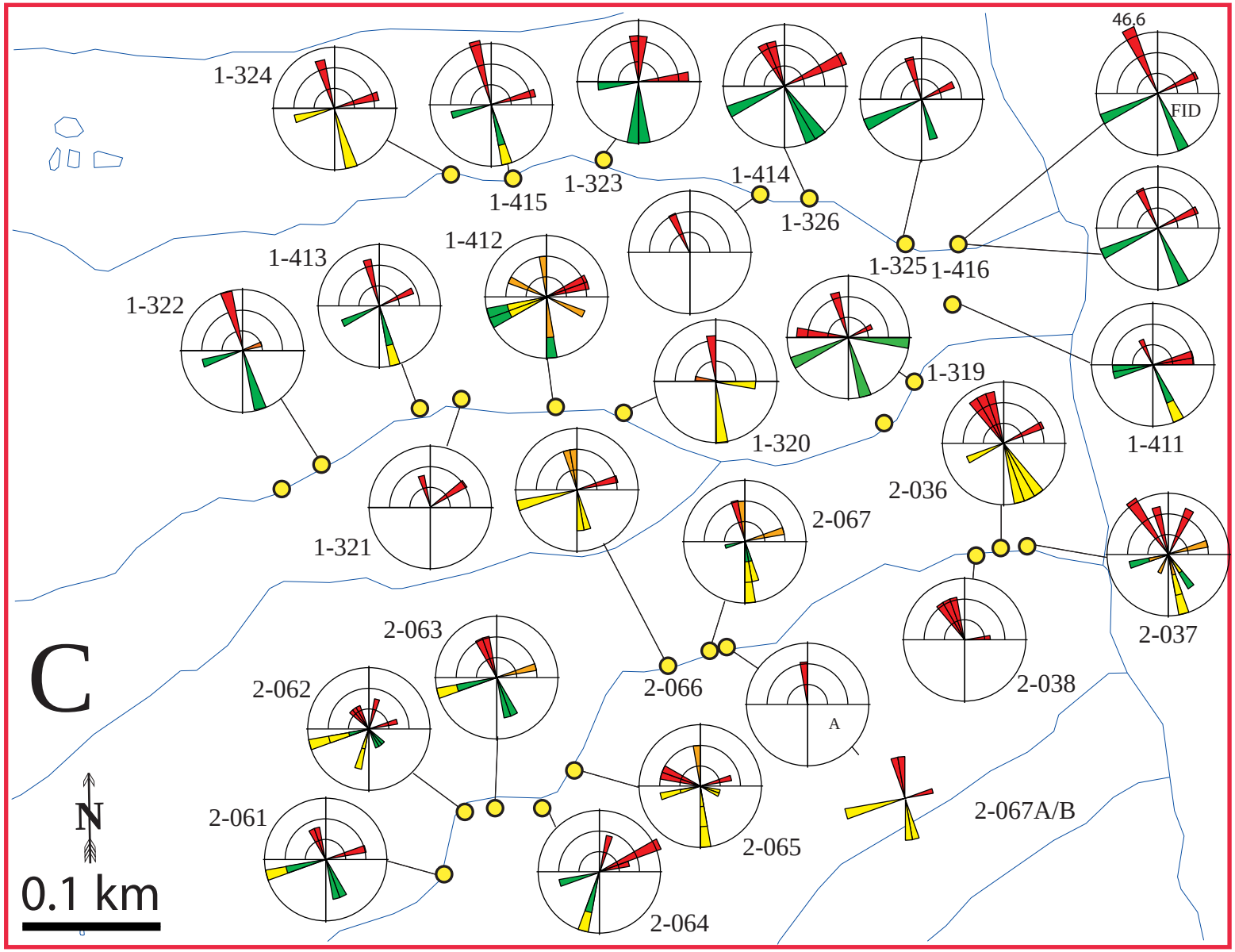

C
1-324
1-415
1-323
1-414
1-326
46.6
FID
1-325
1-416
1-412
1-413
1-322
1-319
1-320
1-411
2-036
1-321
2-067
2-037
2-063
2-062
2-066
2-038
A
2-061
2-065
2-067A/B
2-064
N
0.1 km

FIGURE 3.1-26

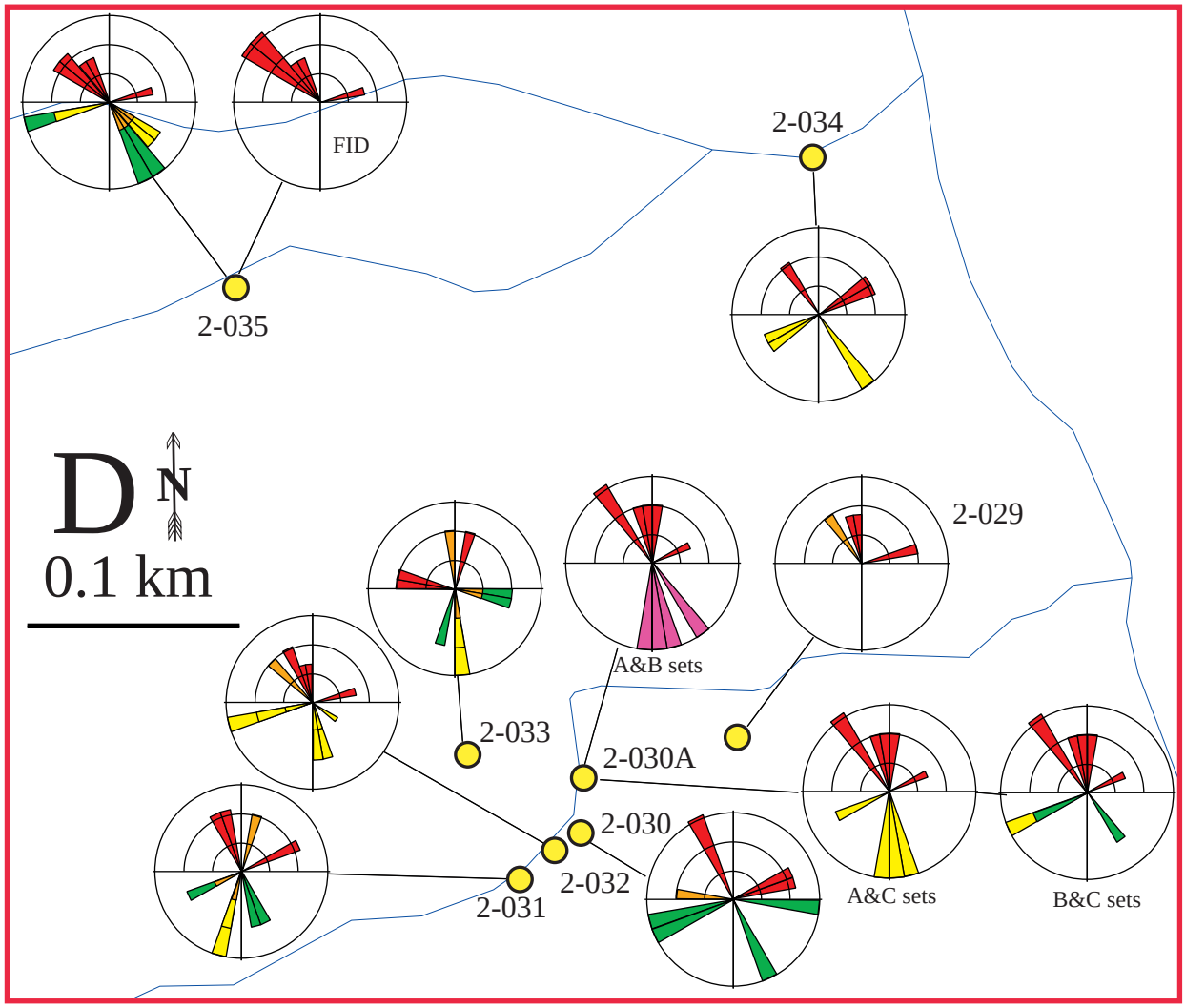

FID
2-034
2-035
D
N
0.1 km
2-029
A&B sets
2-033
2-030A
2-030
2-032
2-031
A&C sets
B&C sets

FIGURE 3.1-27

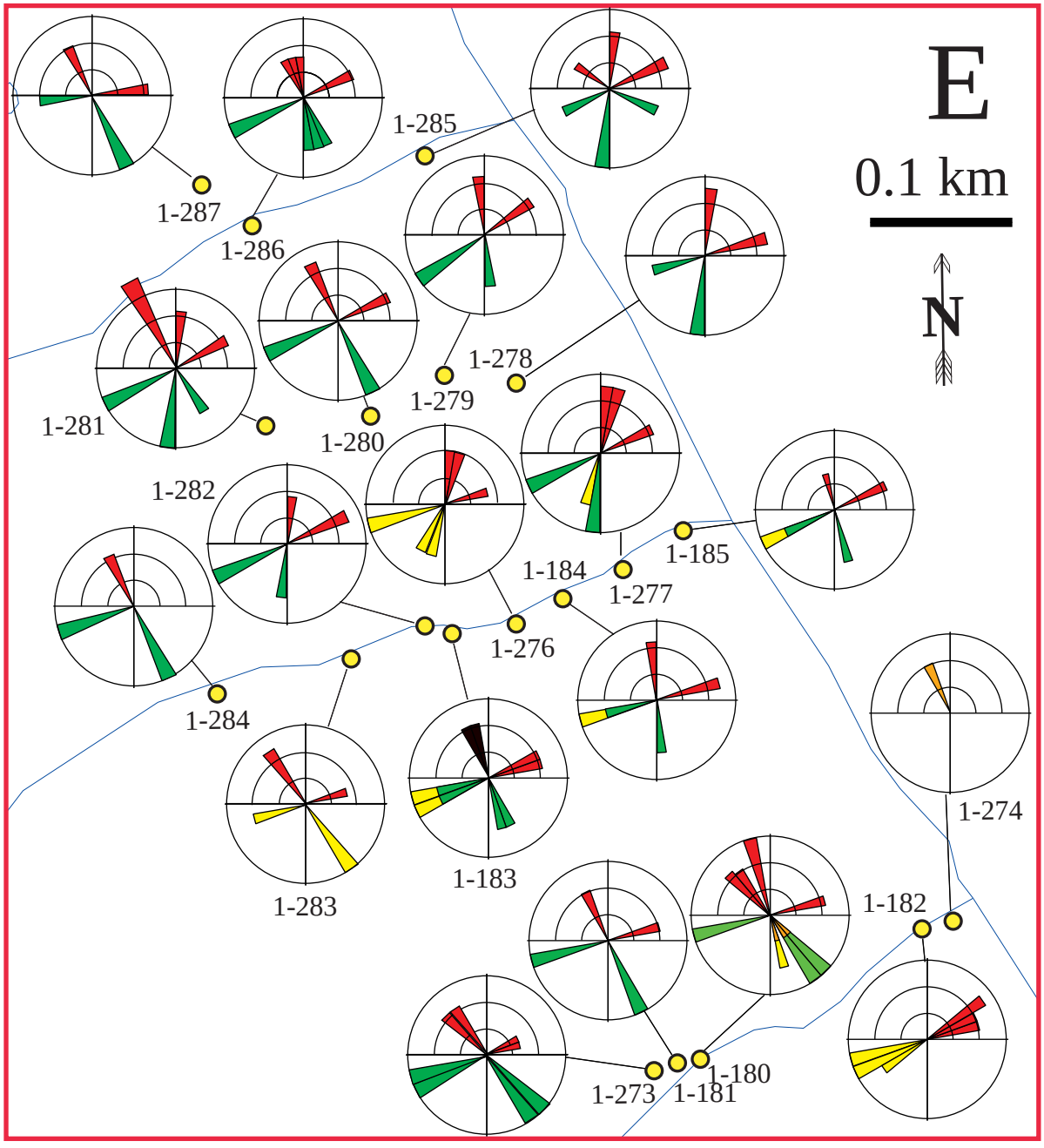

E
0.1 km
N
1-285
1-287
1-286
1-278
1-279
1-281
1-280
1-282
1-185
1-184
1-277
1-276
1-284
1-274
1-183
1-283
1-182
1-273
1-181
1-180

FIGURE 3.1-28

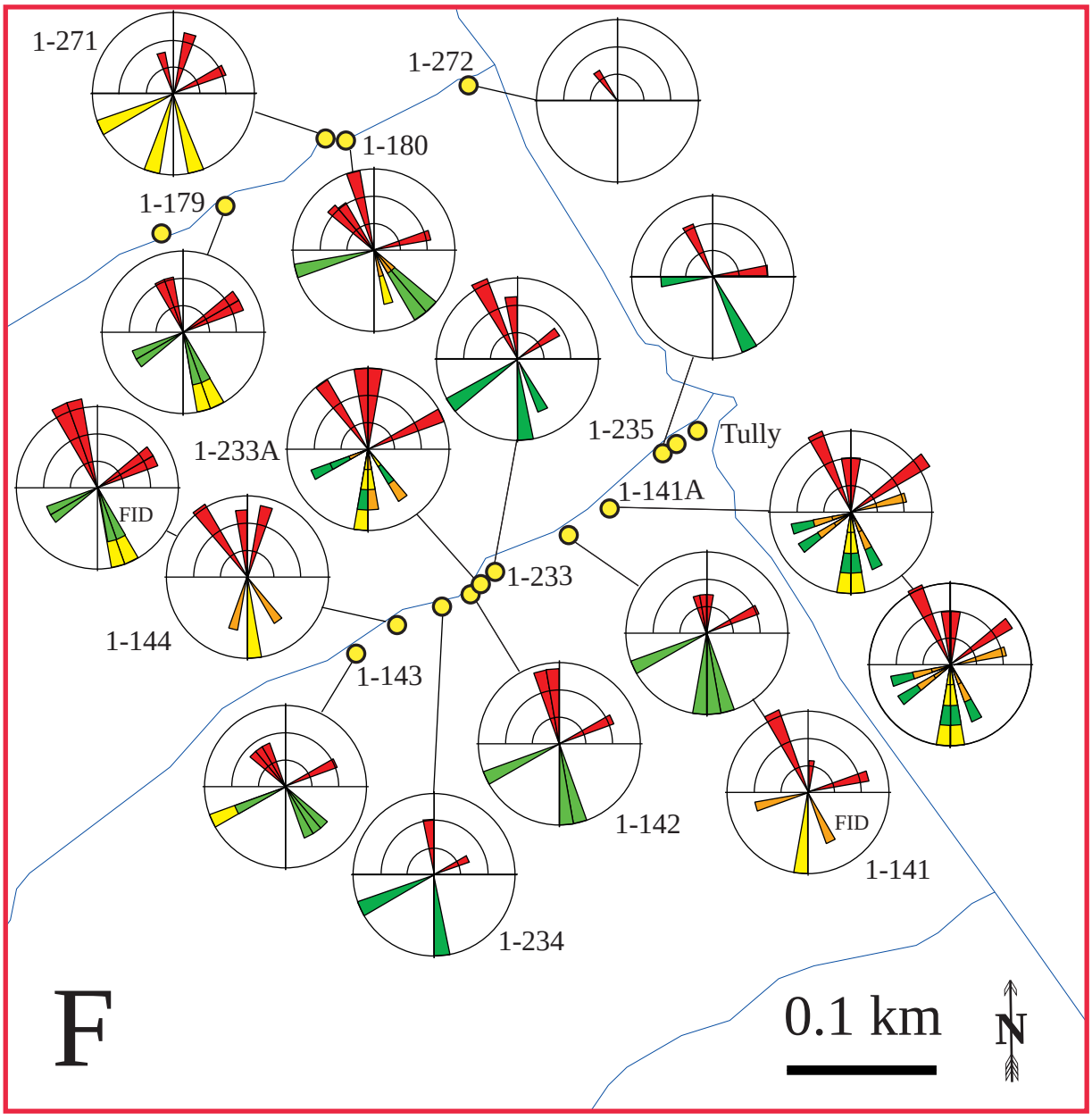

1-271
1-272
1-180
1-179
1-233A
1-235
Tully
1-141A
FID
1-233
1-144
1-143
1-142
FID
1-141
1-234
F
0.1 km
N

FIGURE 3.1-29

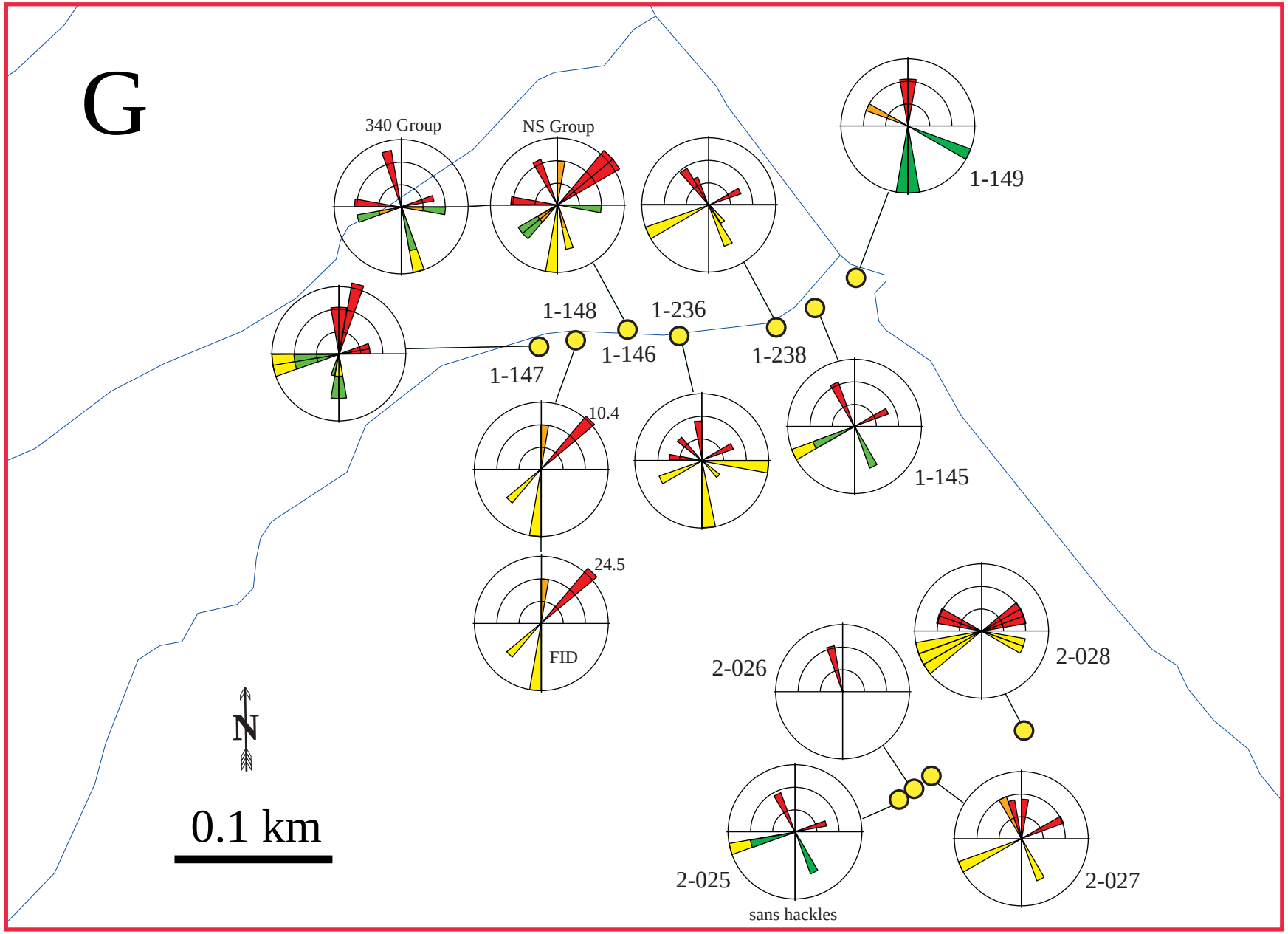

G
340 Group
NS Group
1-149
1-148
1-236
1-146
1-147
1-238
10.4
1-145
24.5
FID
2-026
2-028
2-025
2-027
sans hackles
N
0.1 km

FIGURE 3.1-30

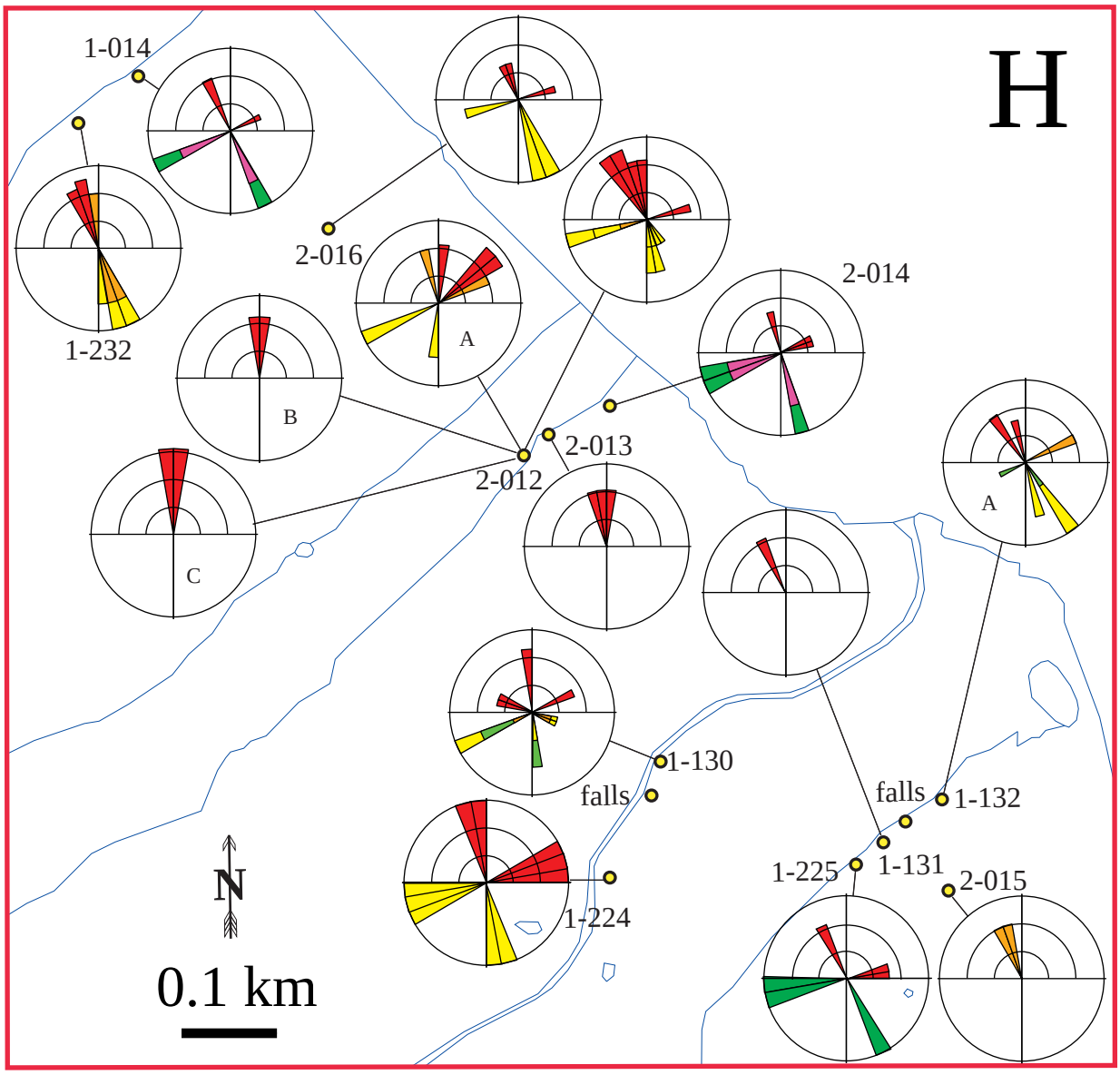

H
1-014
2-016
2-014
1-232
A
B
2-013
2-012
C
A
1-130
falls
falls
1-132
1-225
1-131
2-015
1-224
N
0.1 km

FIGURE 3.1-31

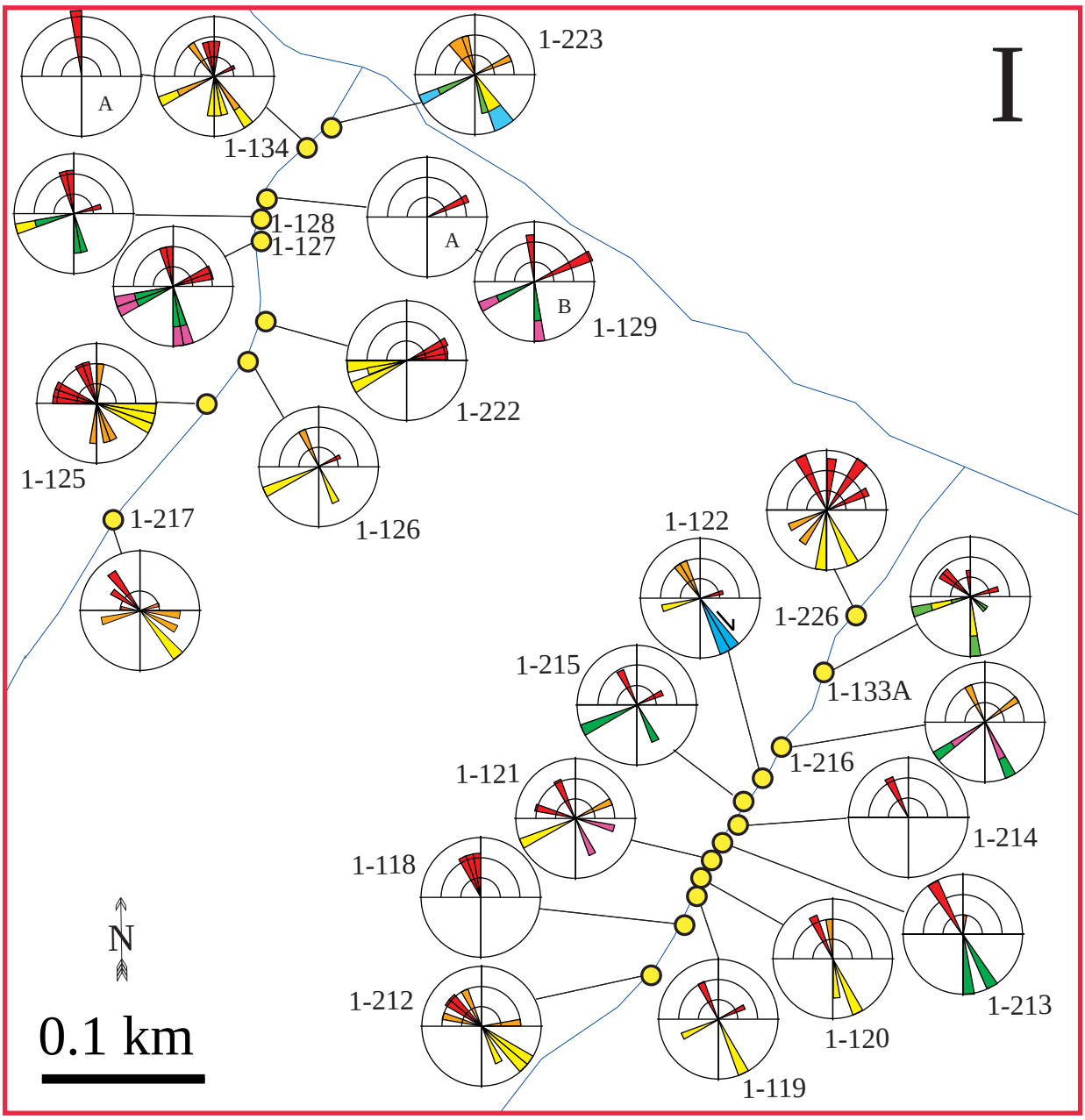

I
1-223
A
1-134
1-128
1-127
A
B
1-129
1-222
1-125
1-126
1-217
1-122
1-226
1-215
1-133A
1-216
1-121
1-214
1-118
1-213
1-212
1-120
1-119
N
0.1 km

FIGURE 3.1-32

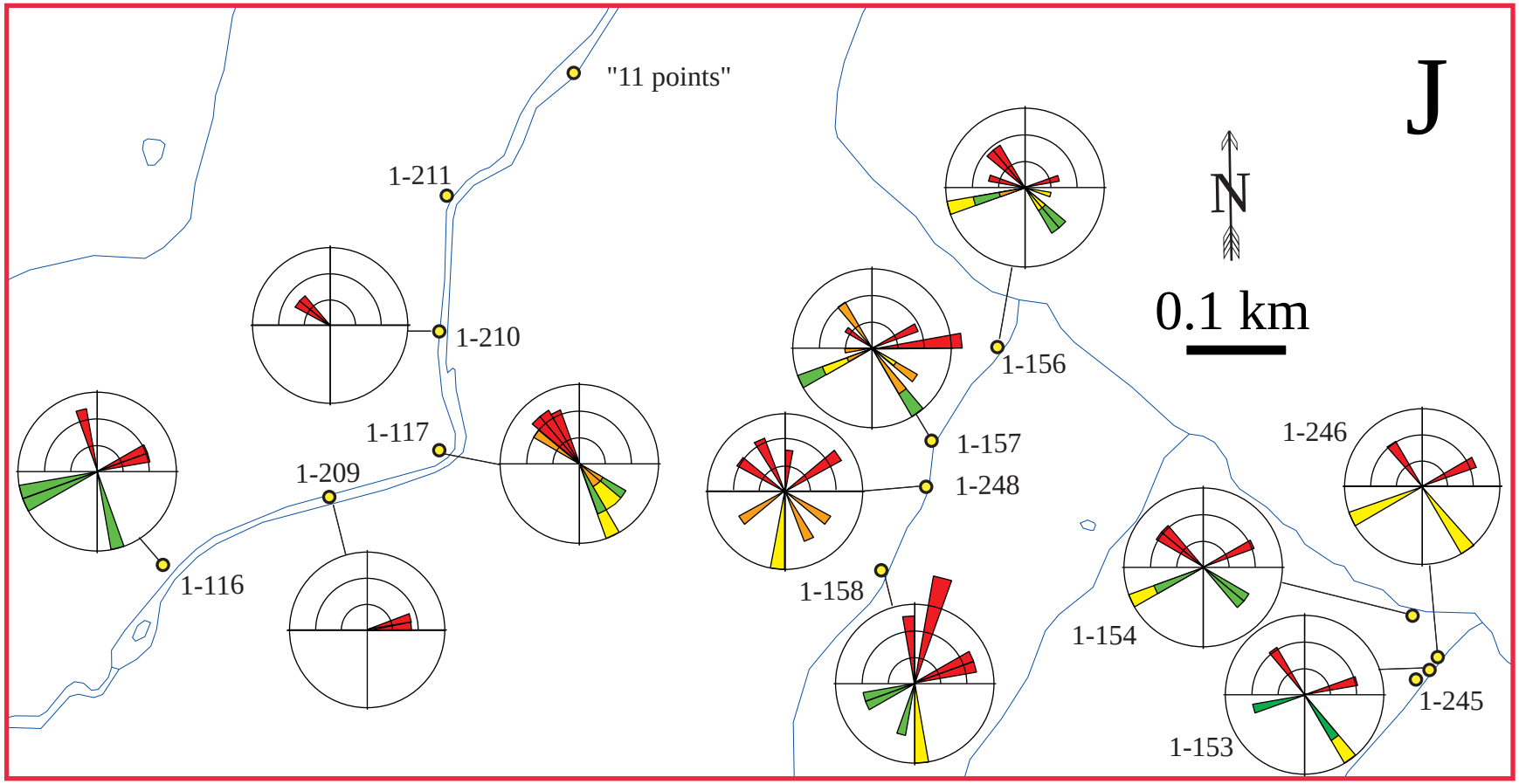

J
N
0.1 km
"11 points"
1-211
1-210
1-117
1-209
1-116
1-156
1-157
1-248
1-158
1-246
1-154
1-245
1-153

FIGURE 3.1-33

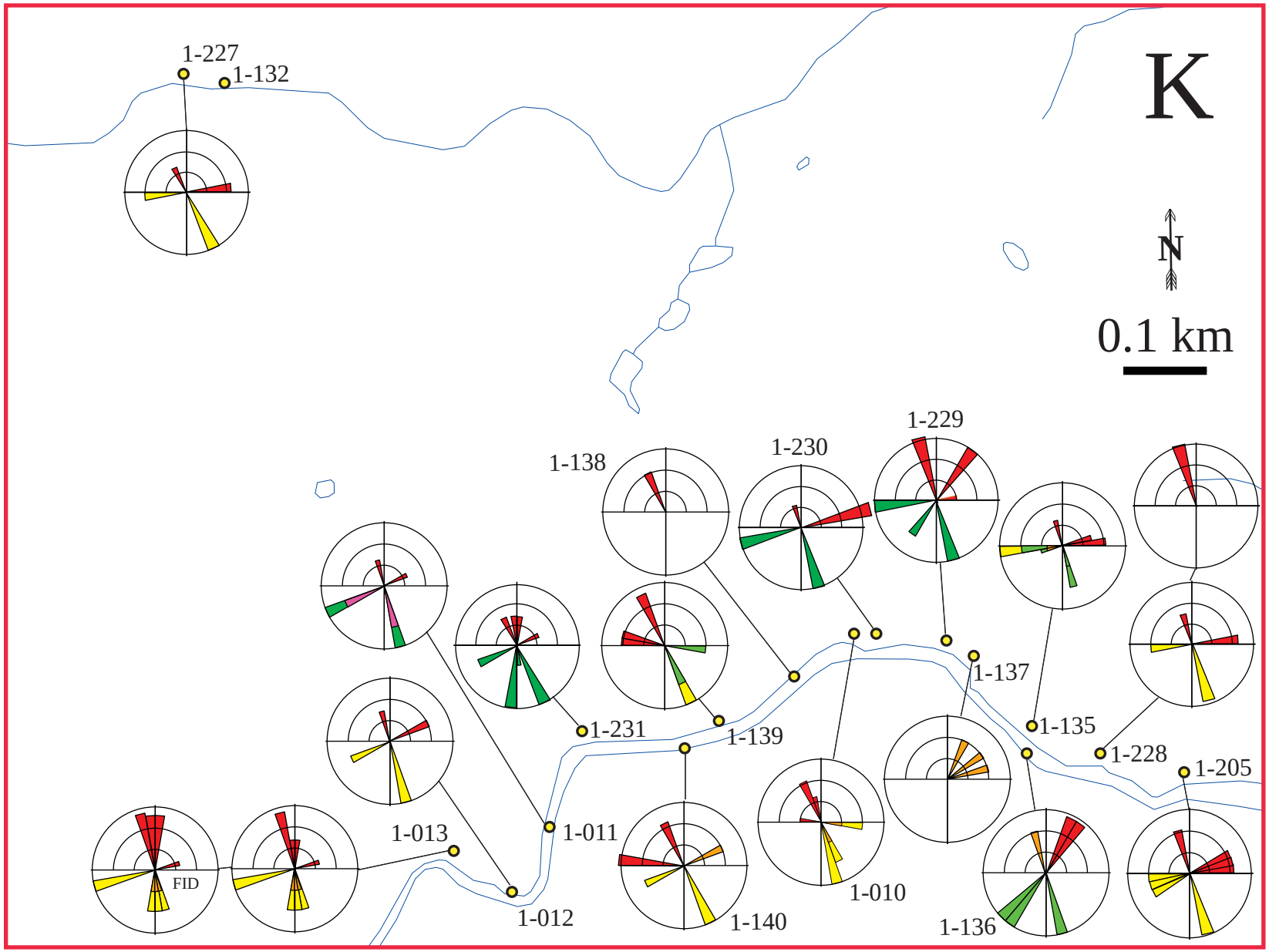

K
N
0.1 km
1-227
1-132
1-138
1-230
1-229
1-137
1-135
1-228
1-205
1-231
1-139
1-011
1-013
1-012
1-140
1-010
1-136
FID

FIGURE 3.1-34

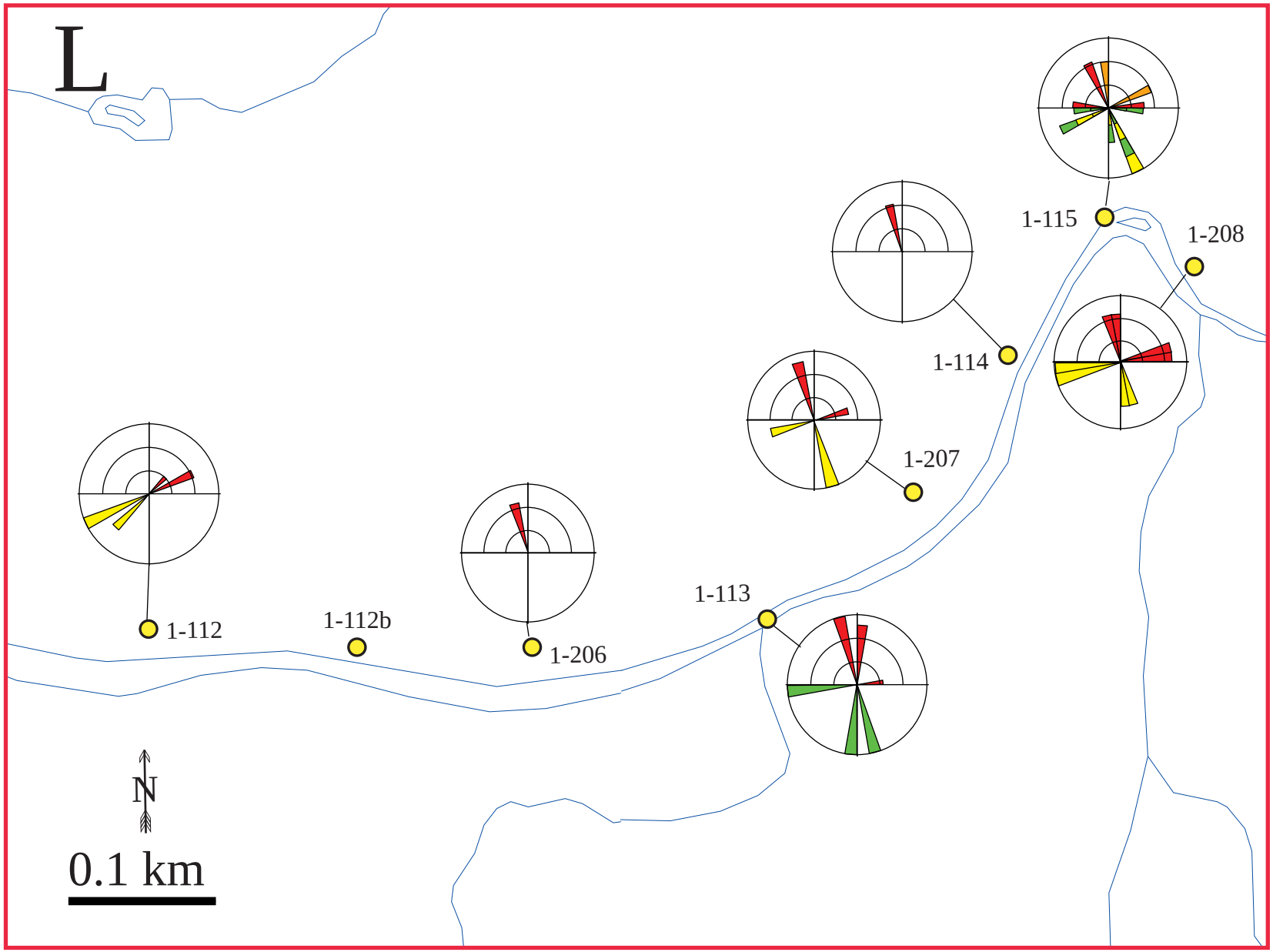


FIGURE 3.1-35

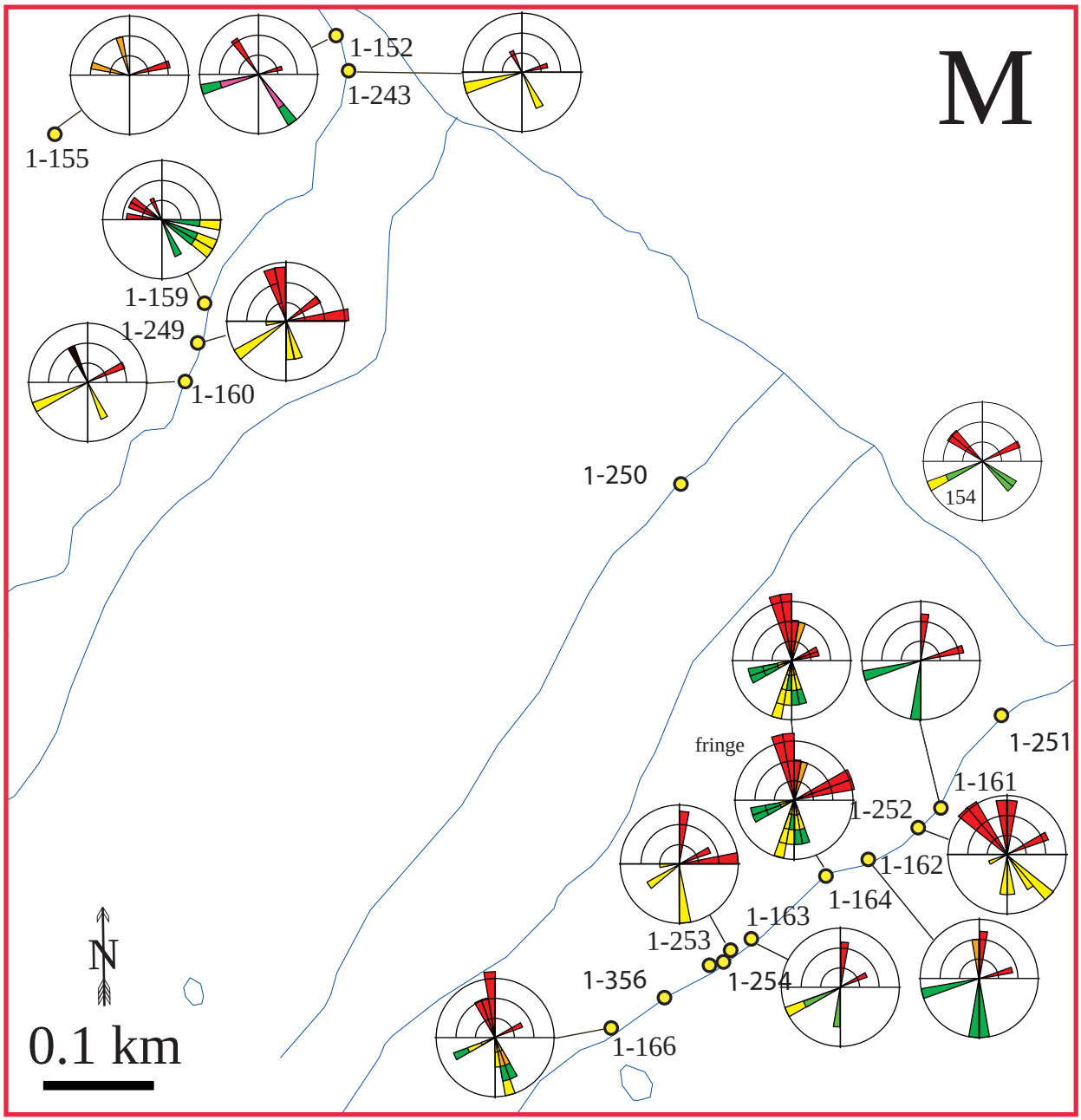

M
1-152
1-243
1-155
1-159
1-249
1-160
1-250
154
fringe
1-251
1-161
1-252
1-162
1-164
1-163
1-253
1-254
1-356
1-166
N
0.1 km

FIGURE 3.1-36

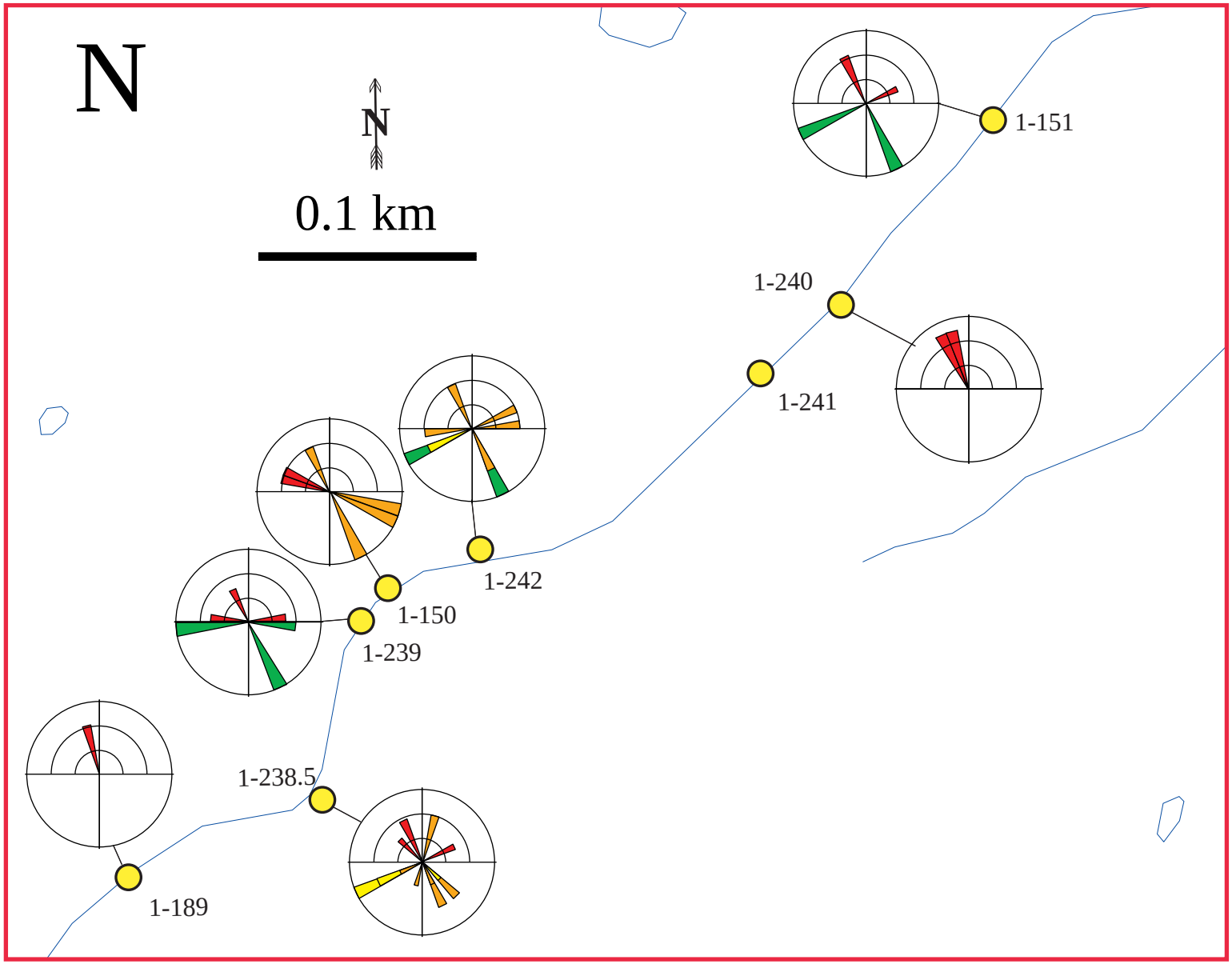


FIGURE 3.1-37

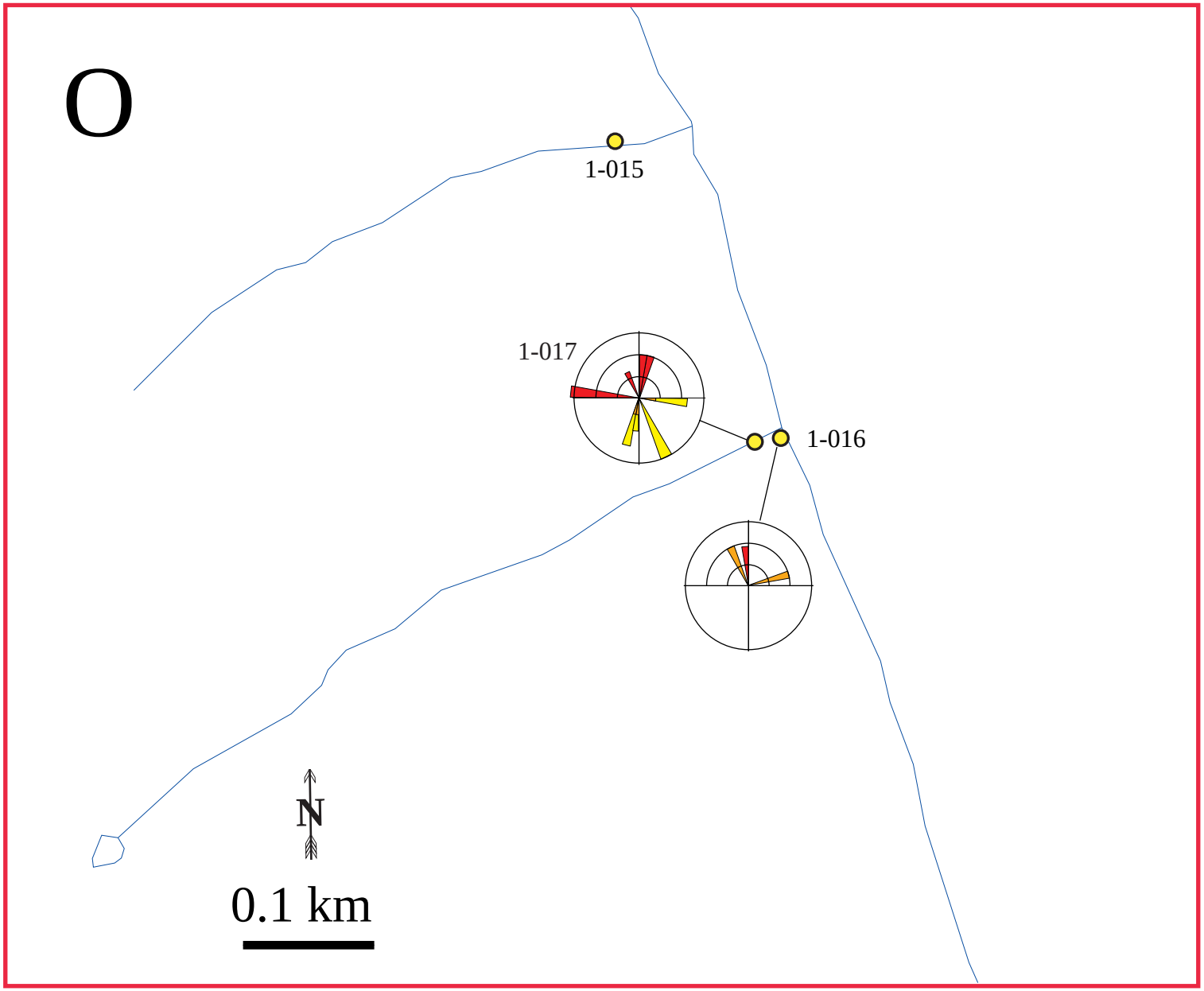


FIGURE 3.1-38

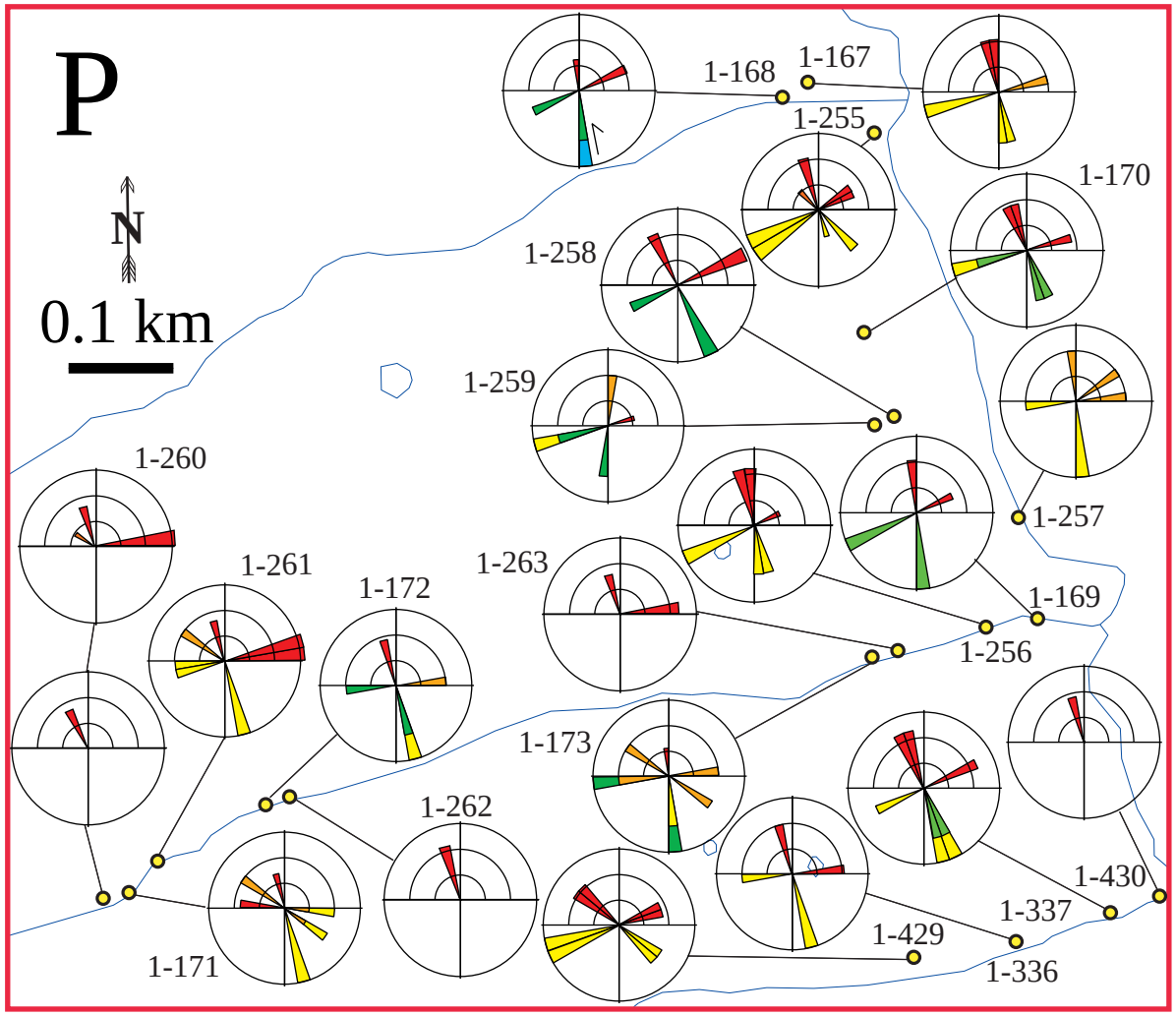

P
N
0.1 km
1-168
1-167
1-255
1-170
1-258
1-259
1-260
1-257
1-261
1-172
1-263
1-169
1-256
1-173
1-262
1-430
1-337
1-429
1-171
1-336

FIGURE 3.1-39

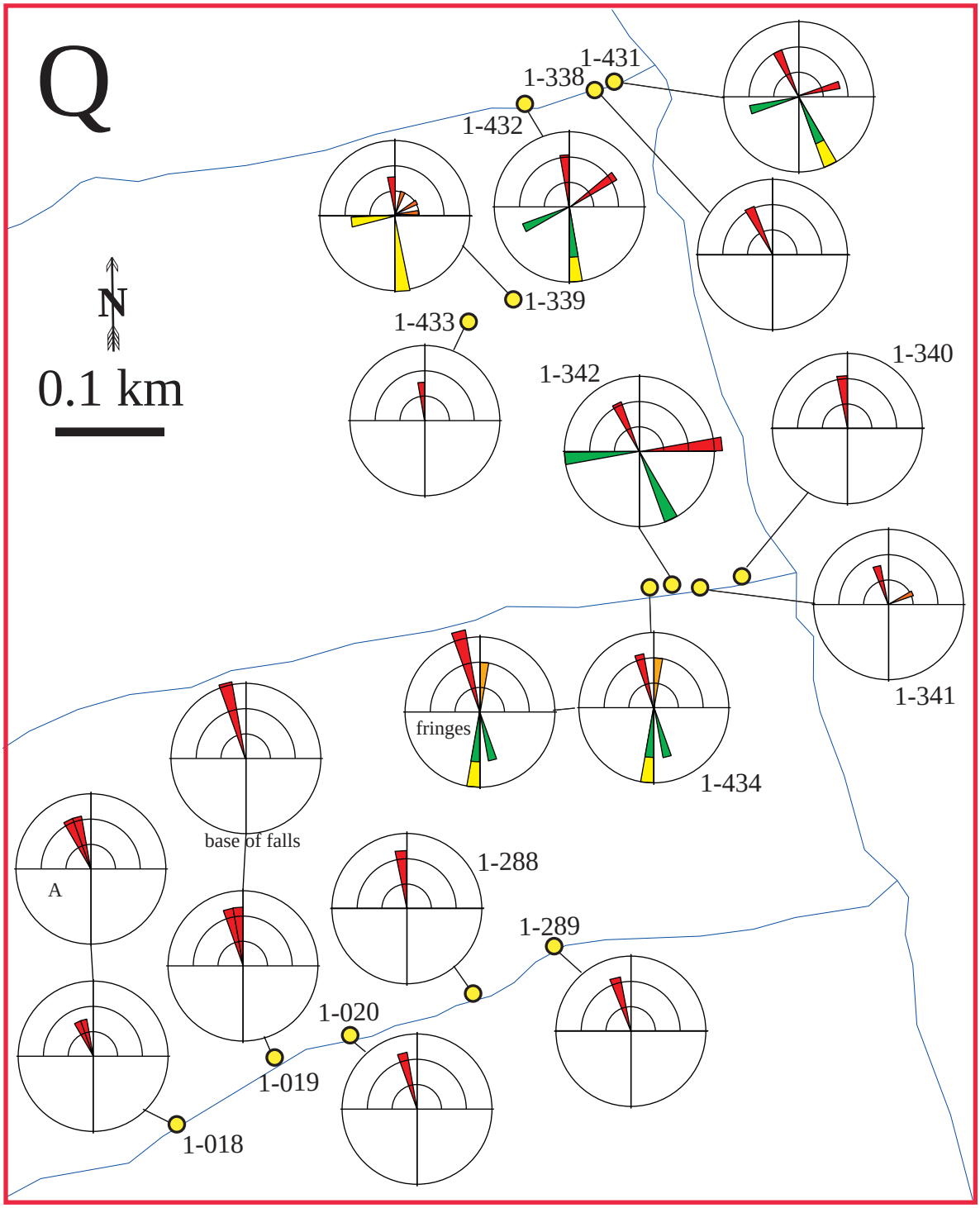

Q
N
0.1 km
1-431
1-338
1-432
1-339
1-433
1-342
1-340
1-341
fringes
1-434
base of falls
A
1-288
1-289
1-020
1-019
1-018

FIGURE 3.1-40

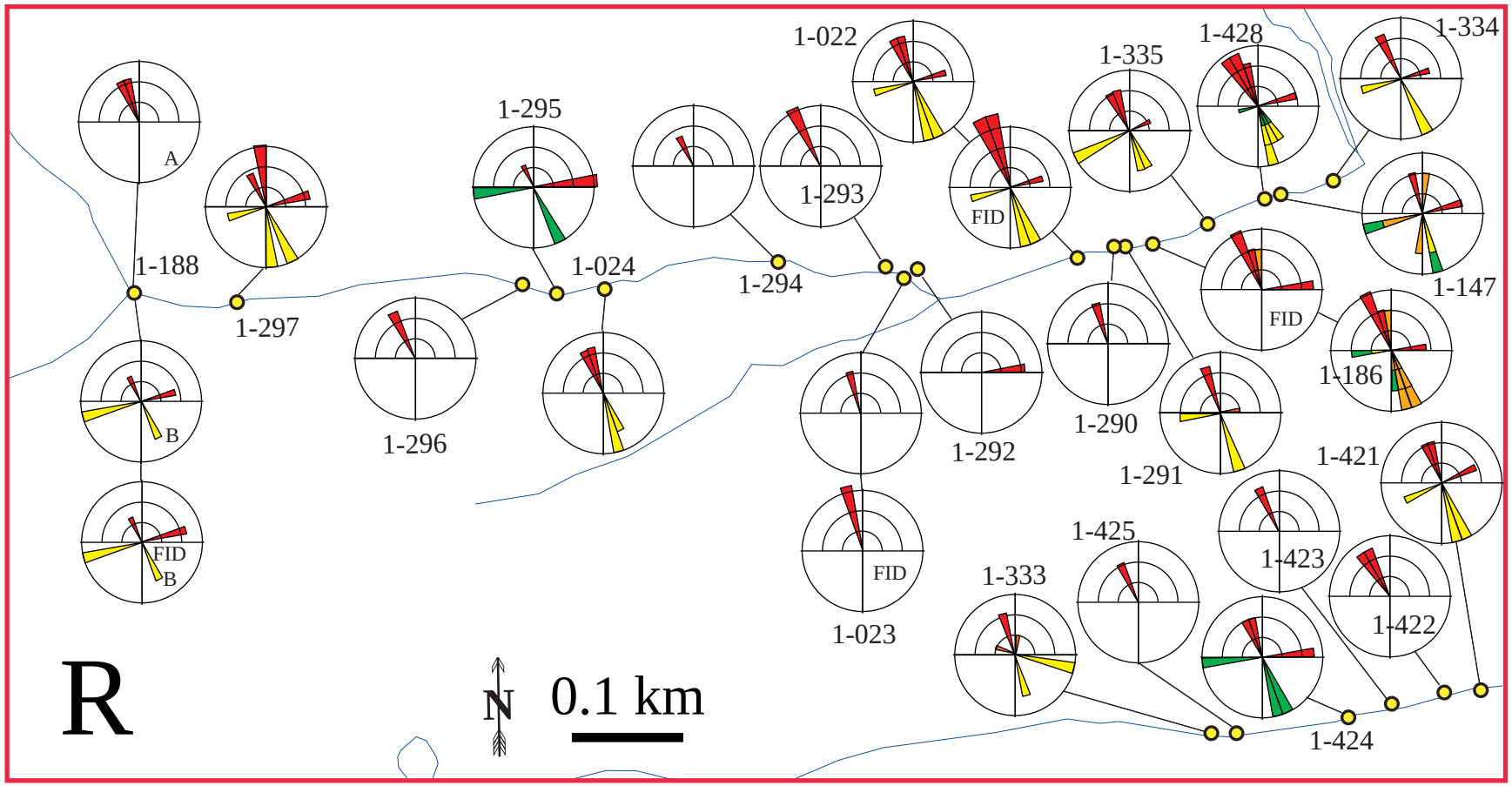

1-022
1-335
1-428
1-334
1-295
1-293
FID
A
1-188
1-297
1-024
1-294
1-147
FID
1-186
1-296
1-290
1-292
1-291
B
1-421
1-425
1-423
FID
B
1-333
1-422
1-023
1-424
R
N
0.1 km

FIGURE 3.1-41

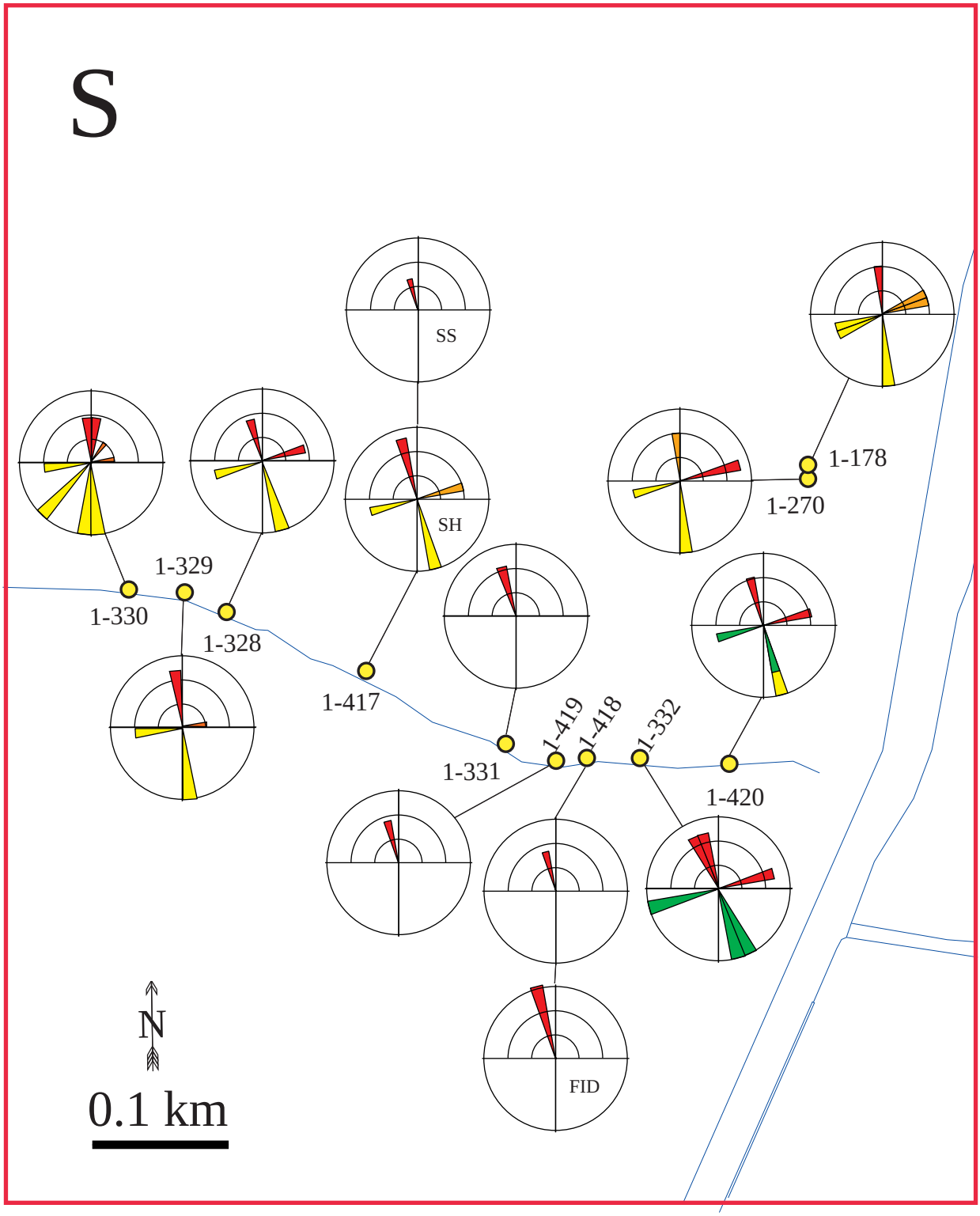

S
SS
SH
FID
1-178
1-270
1-329
1-330
1-328
1-417
1-331
1-419
1-418
1-332
1-420
N
0.1 km

FIGURE 3.1-42

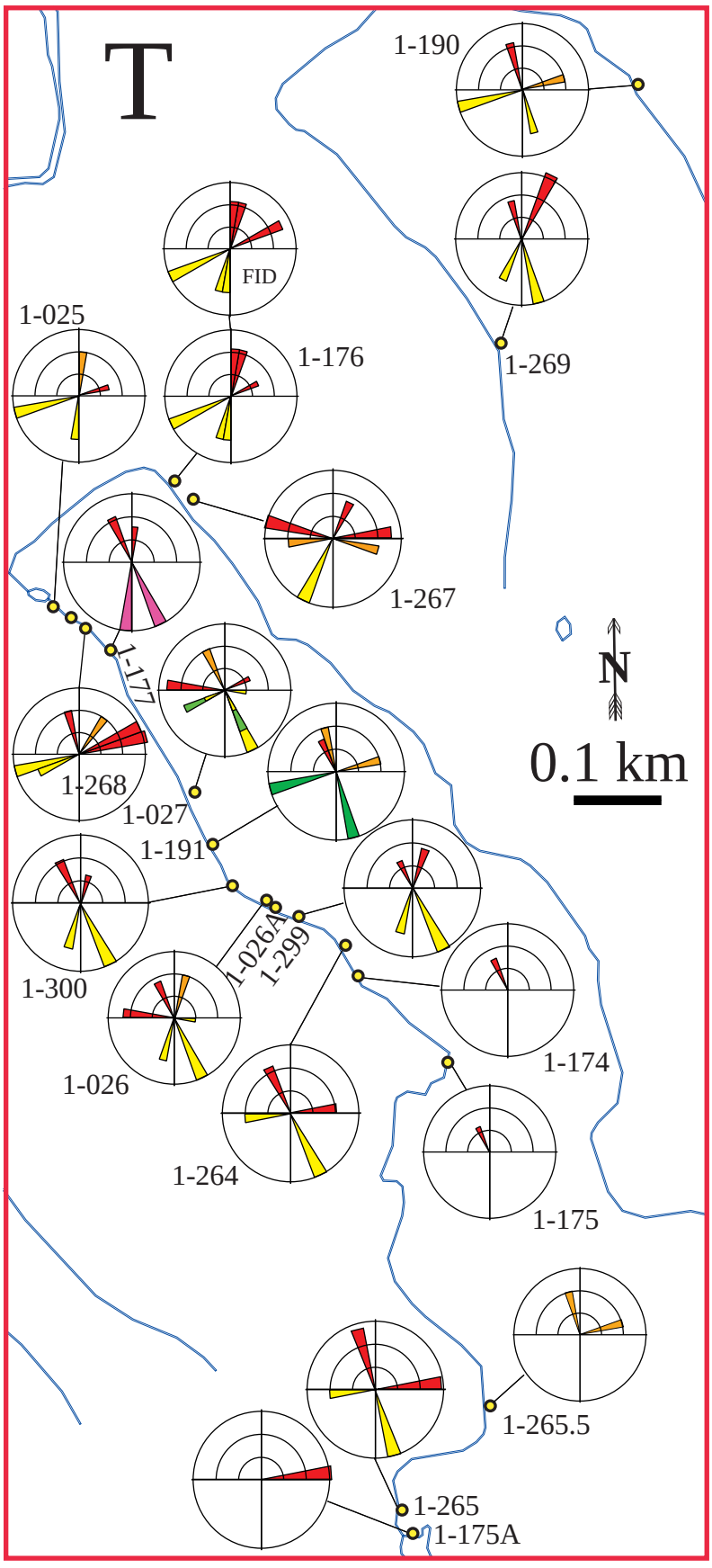
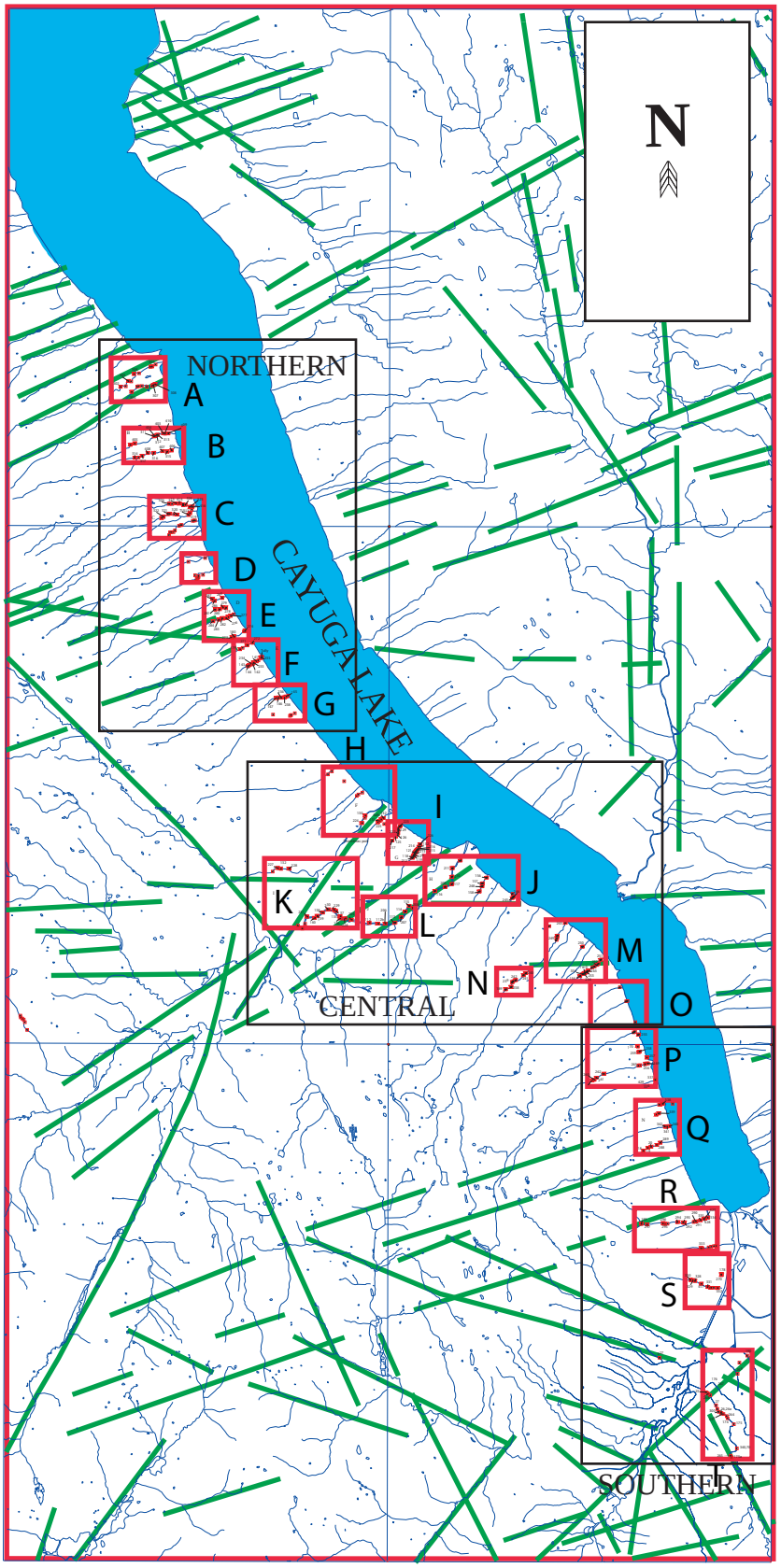

T
1-190
FID
1-025
1-176
1-269
1-267
1-177
N
0.1 km
1-268
1-027
1-191
1-026A
1-299
1-300
1-026
1-174
1-264
1-175
1-265.5
1-265
1-175A

FIGURE 3.1-43



CAYUGA LAKE LOCATION MAP FOR INSETS

FIGURE 3.1-44

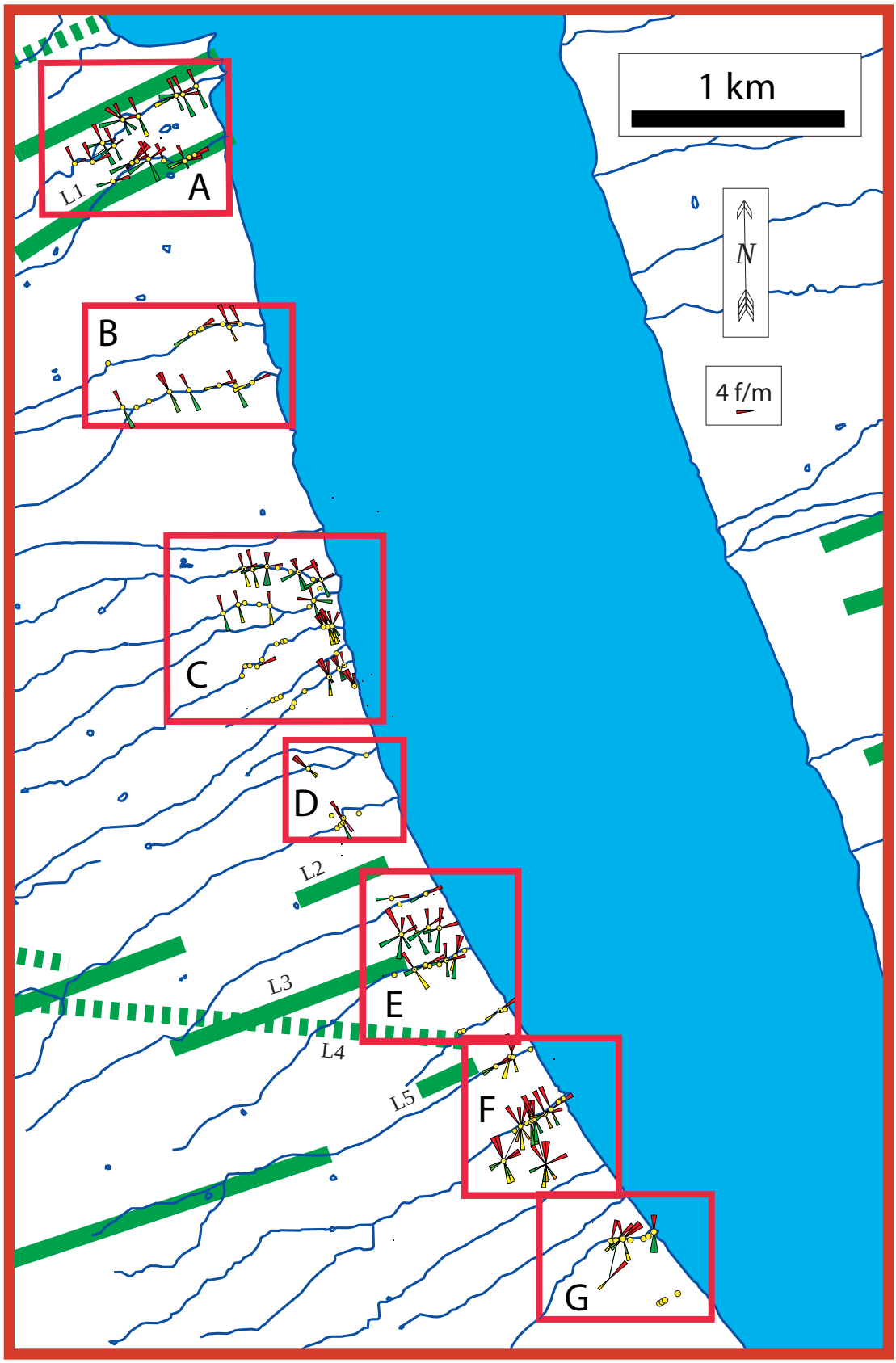


FIGURE 3.1-45

FIGURE 3.1-46

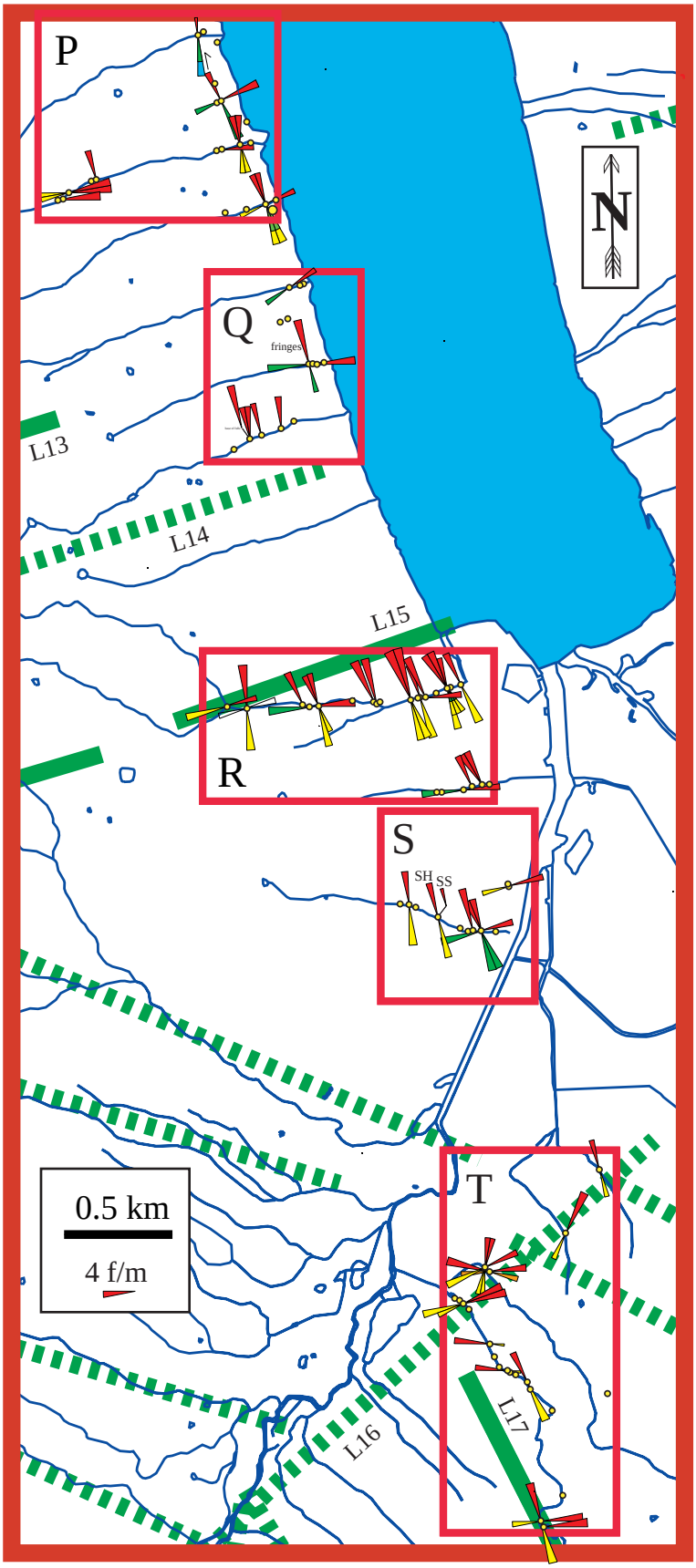


FIGURE 3.1-47

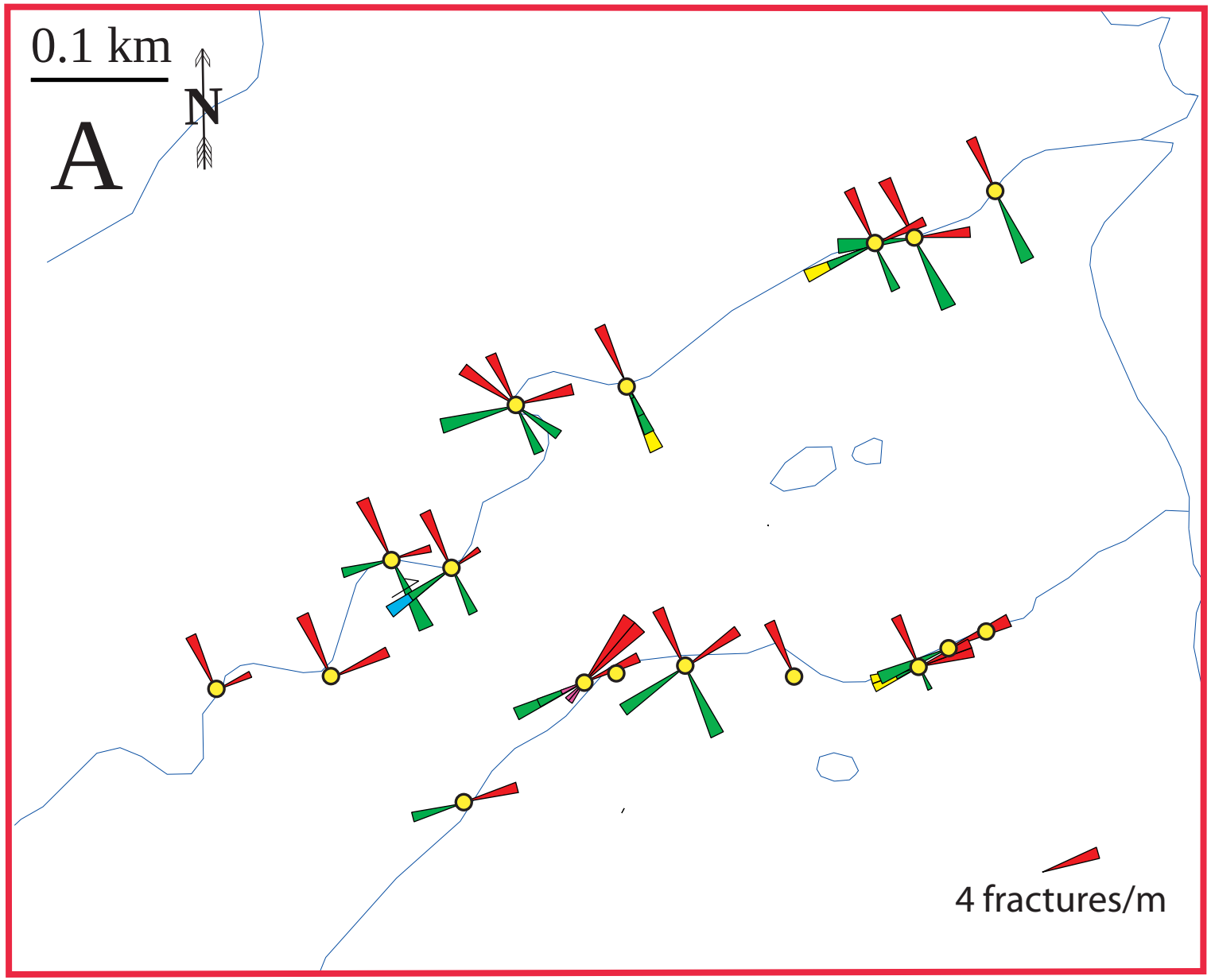


FIGURE 3.1-48

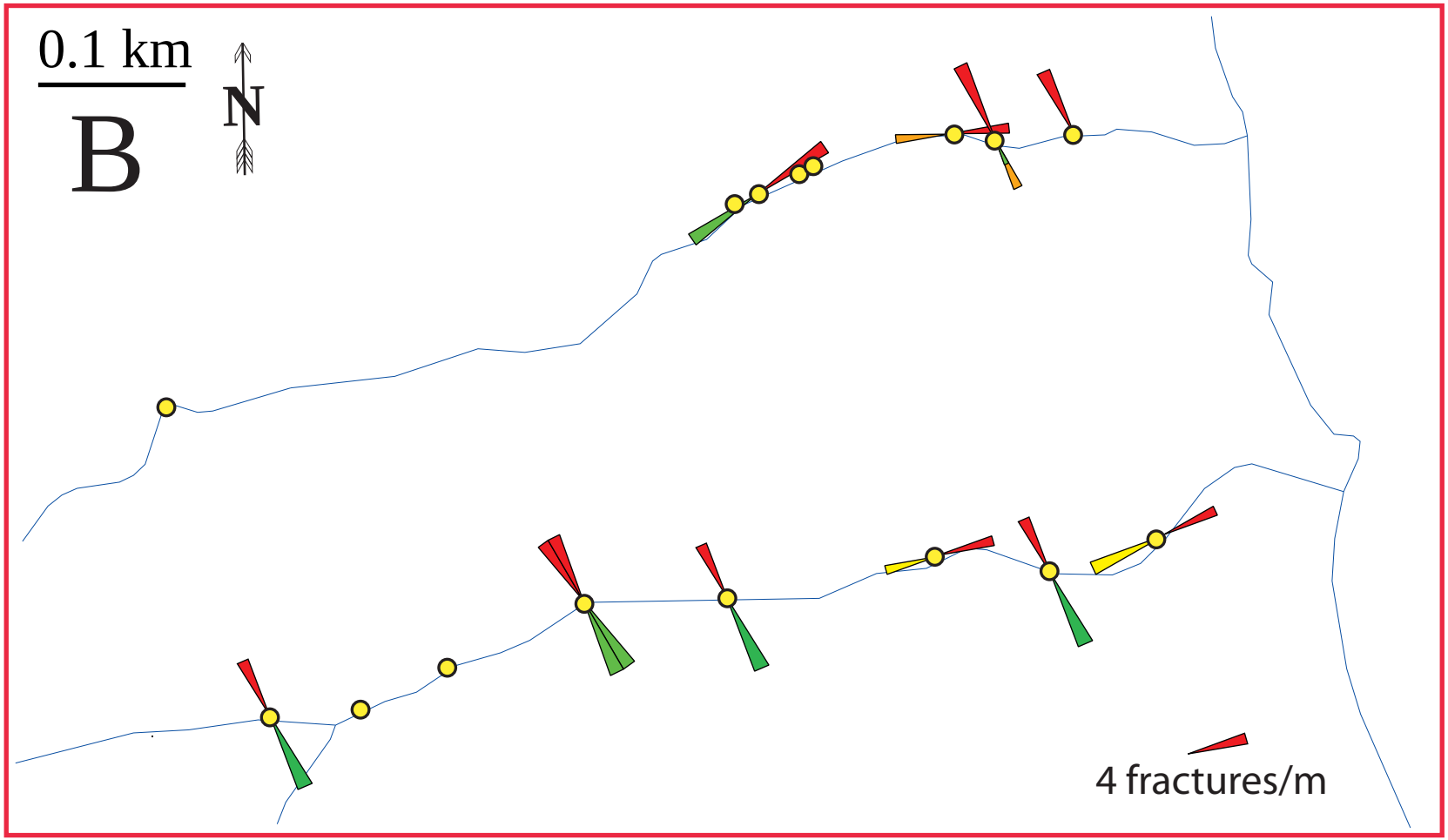


FIGURE 3.1-49

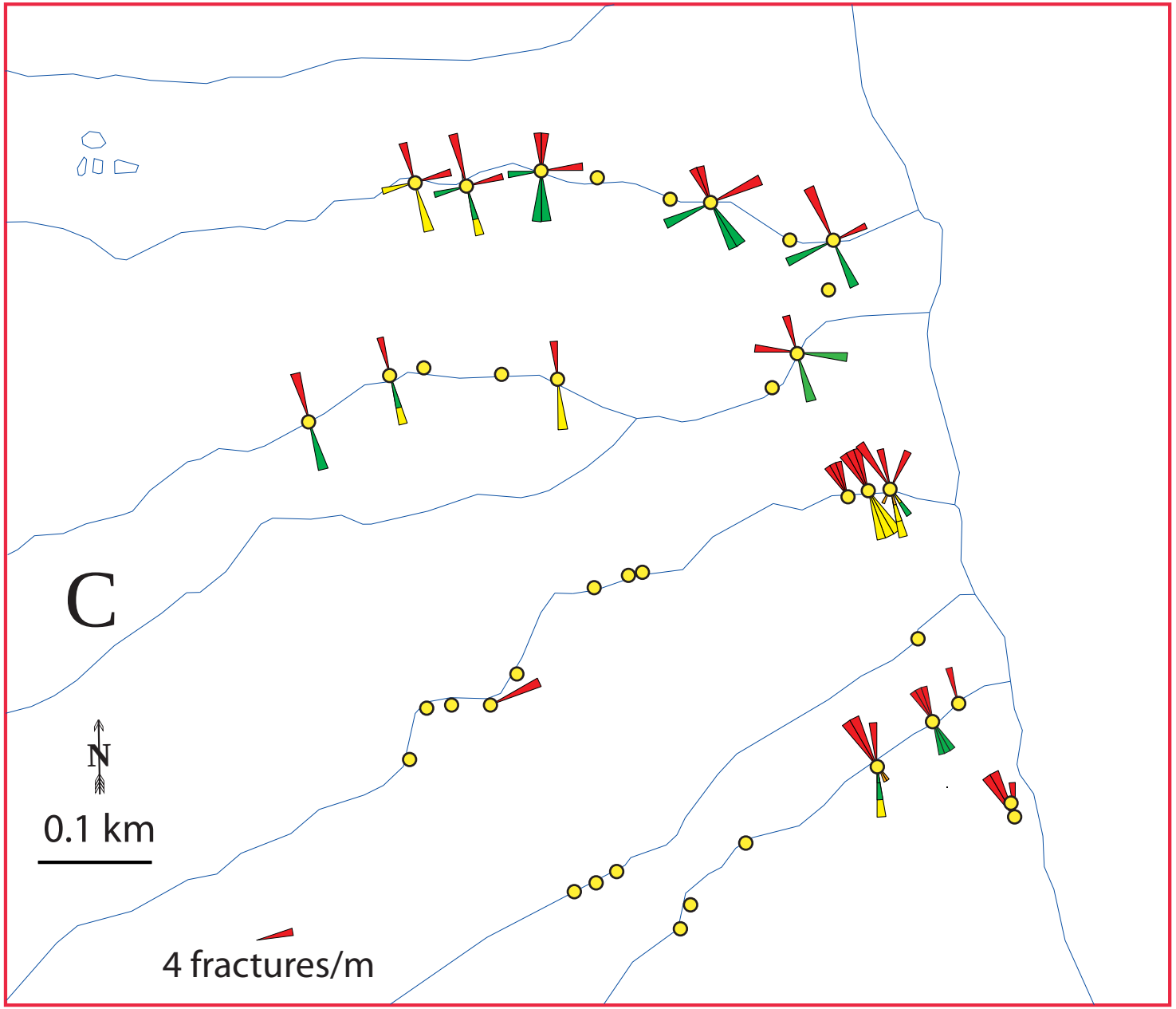


FIGURE 3.1-50

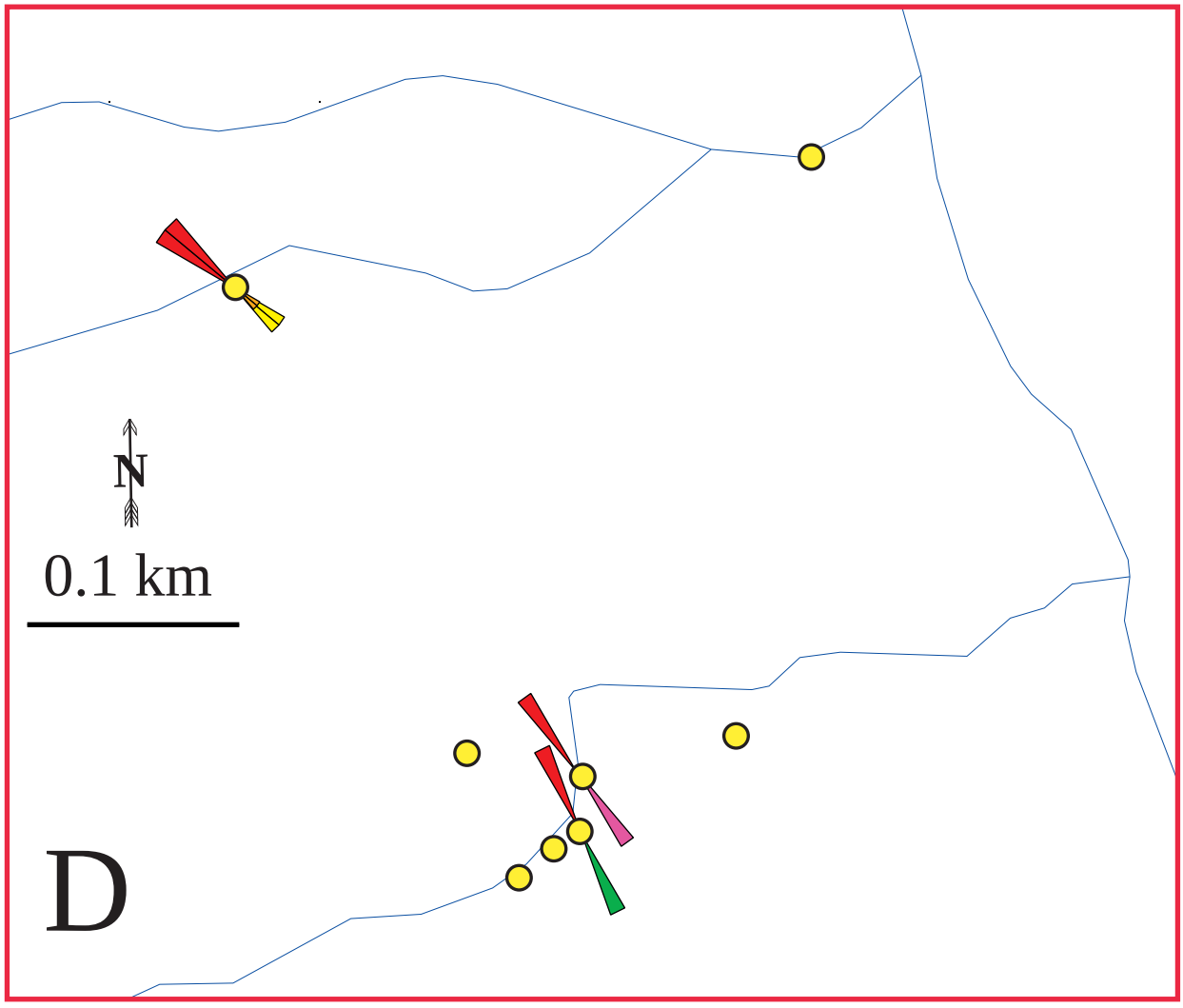


FIGURE 3.1-51

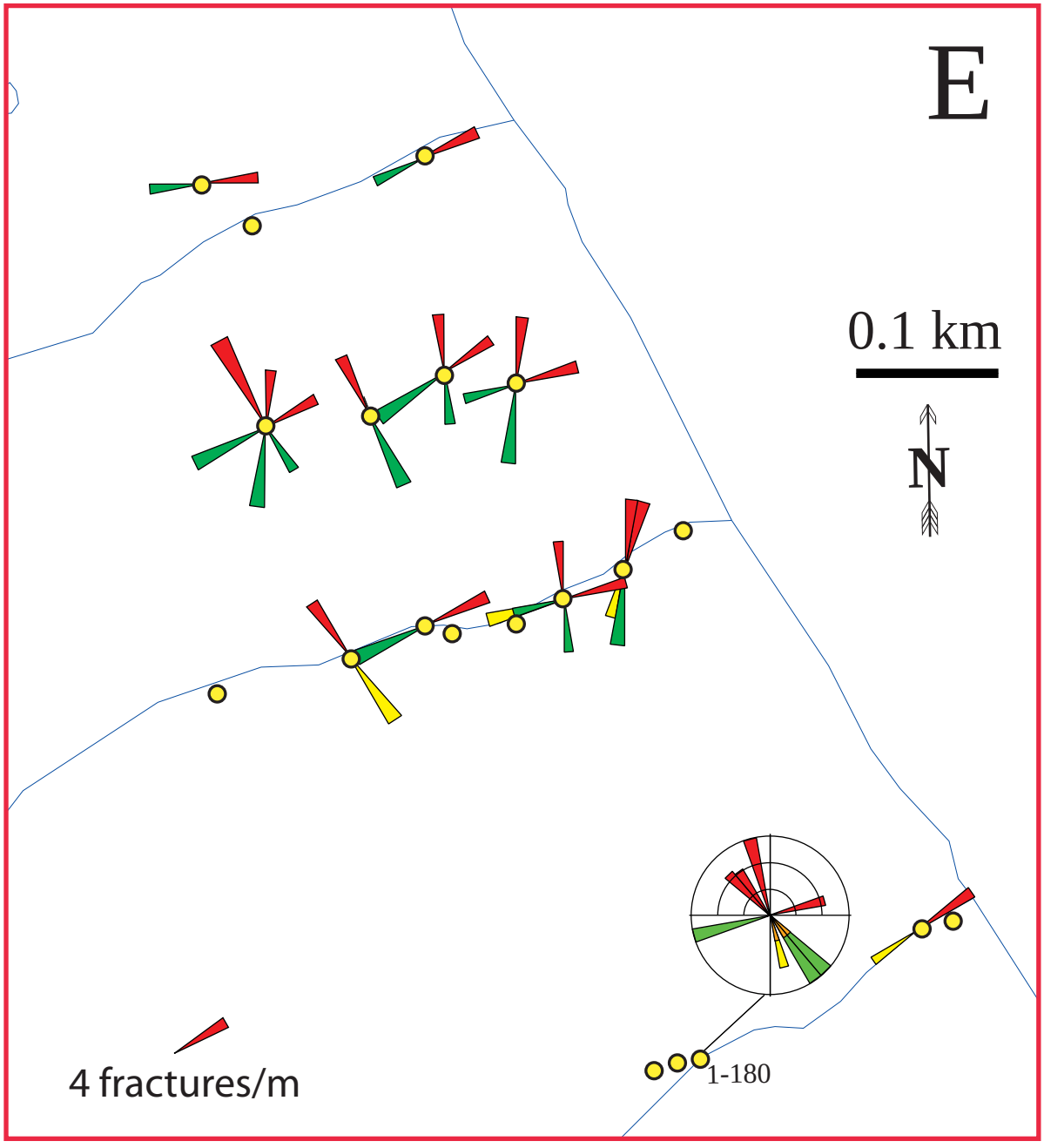


FIGURE 3.1-52

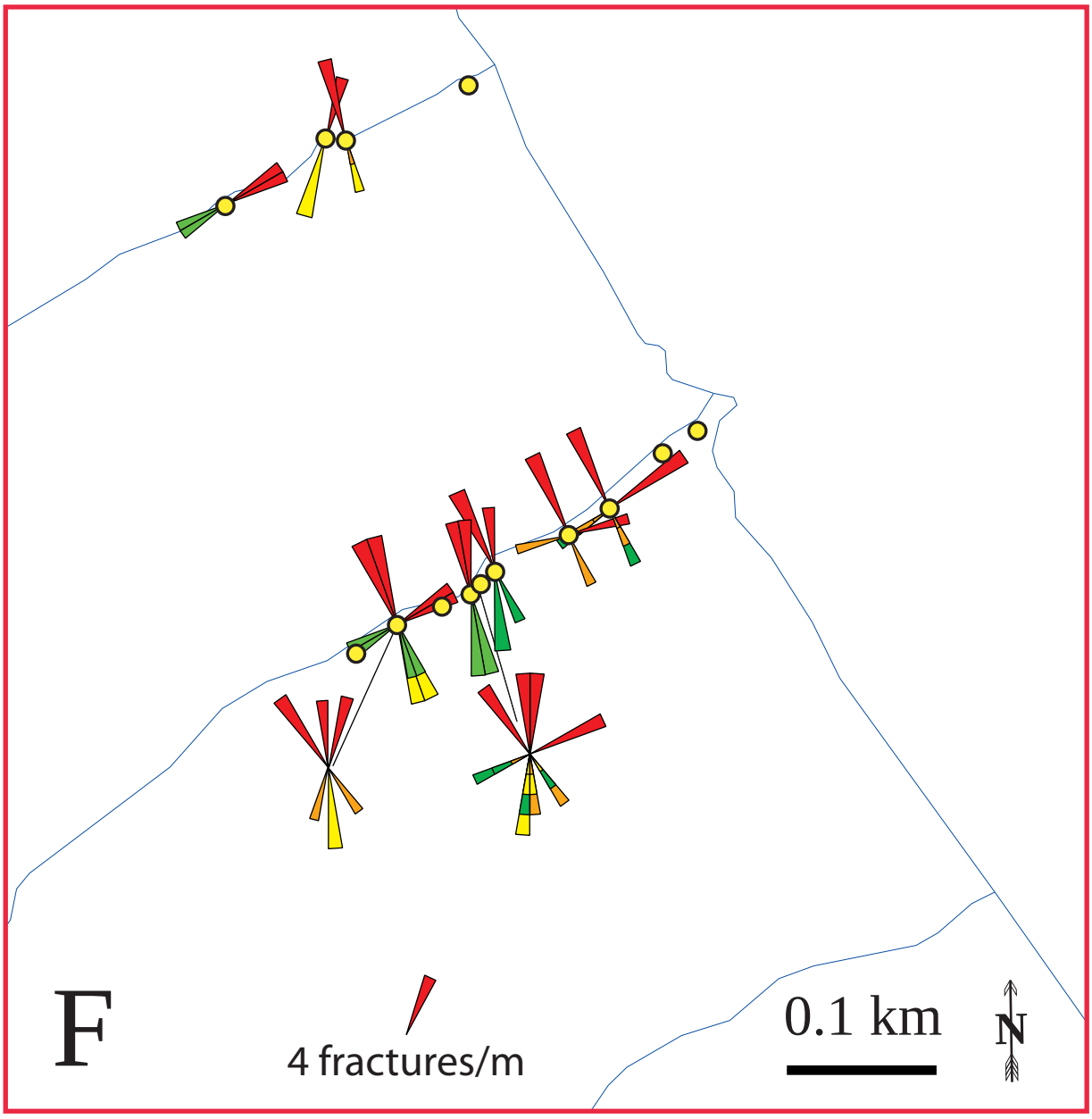


FIGURE 3.1-53

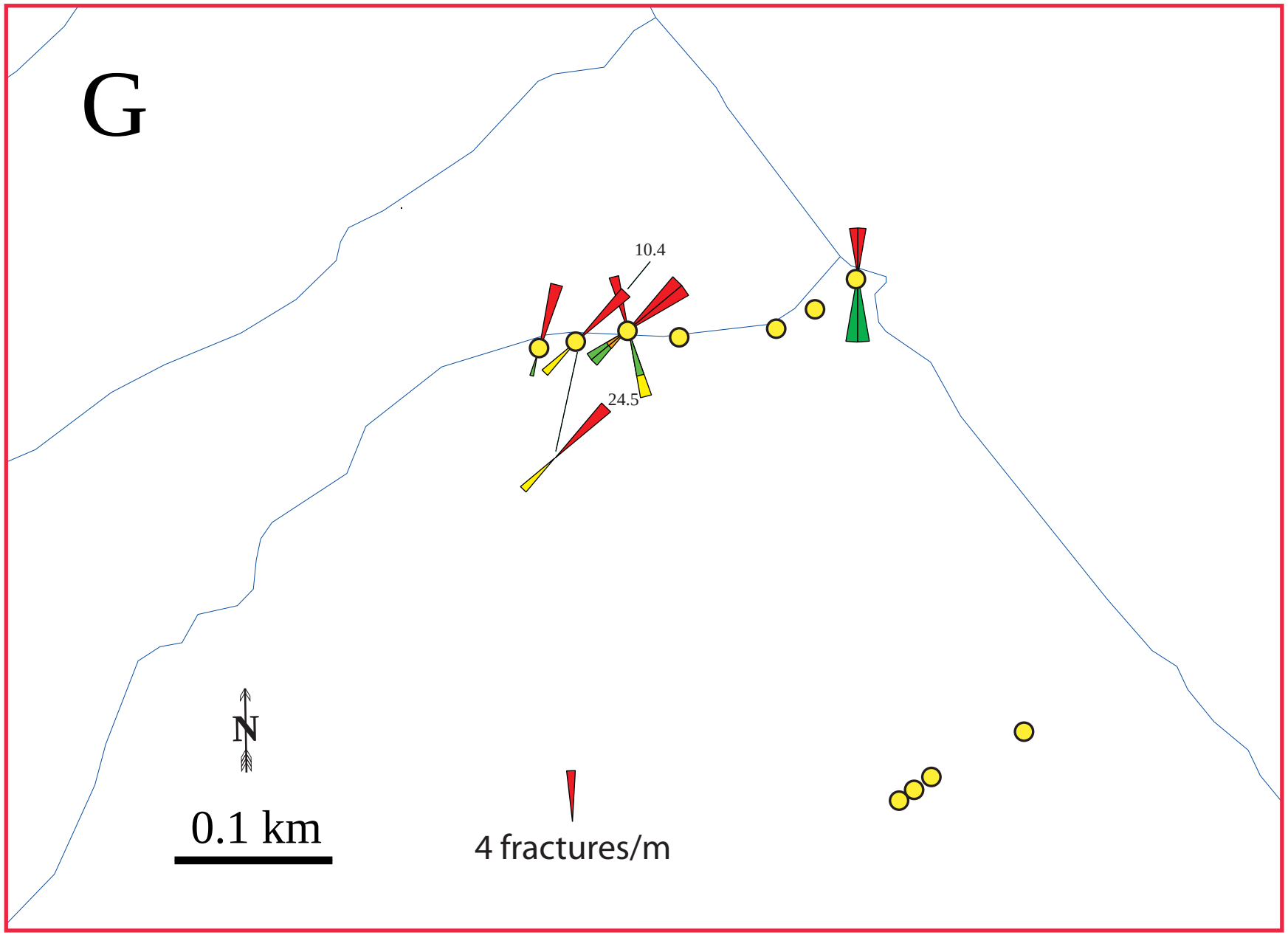


FIGURE 3.1-54

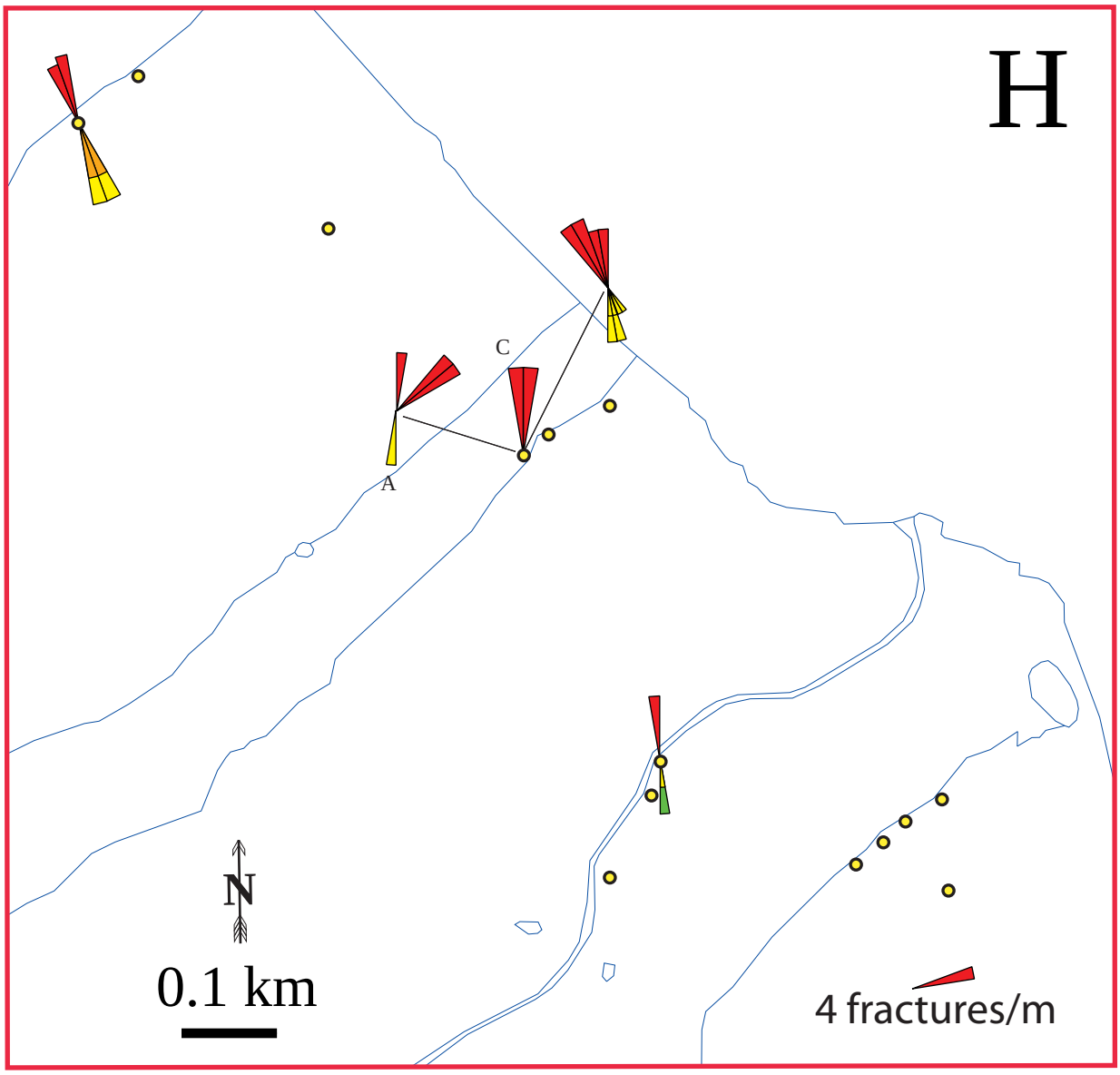


FIGURE 3.1-55

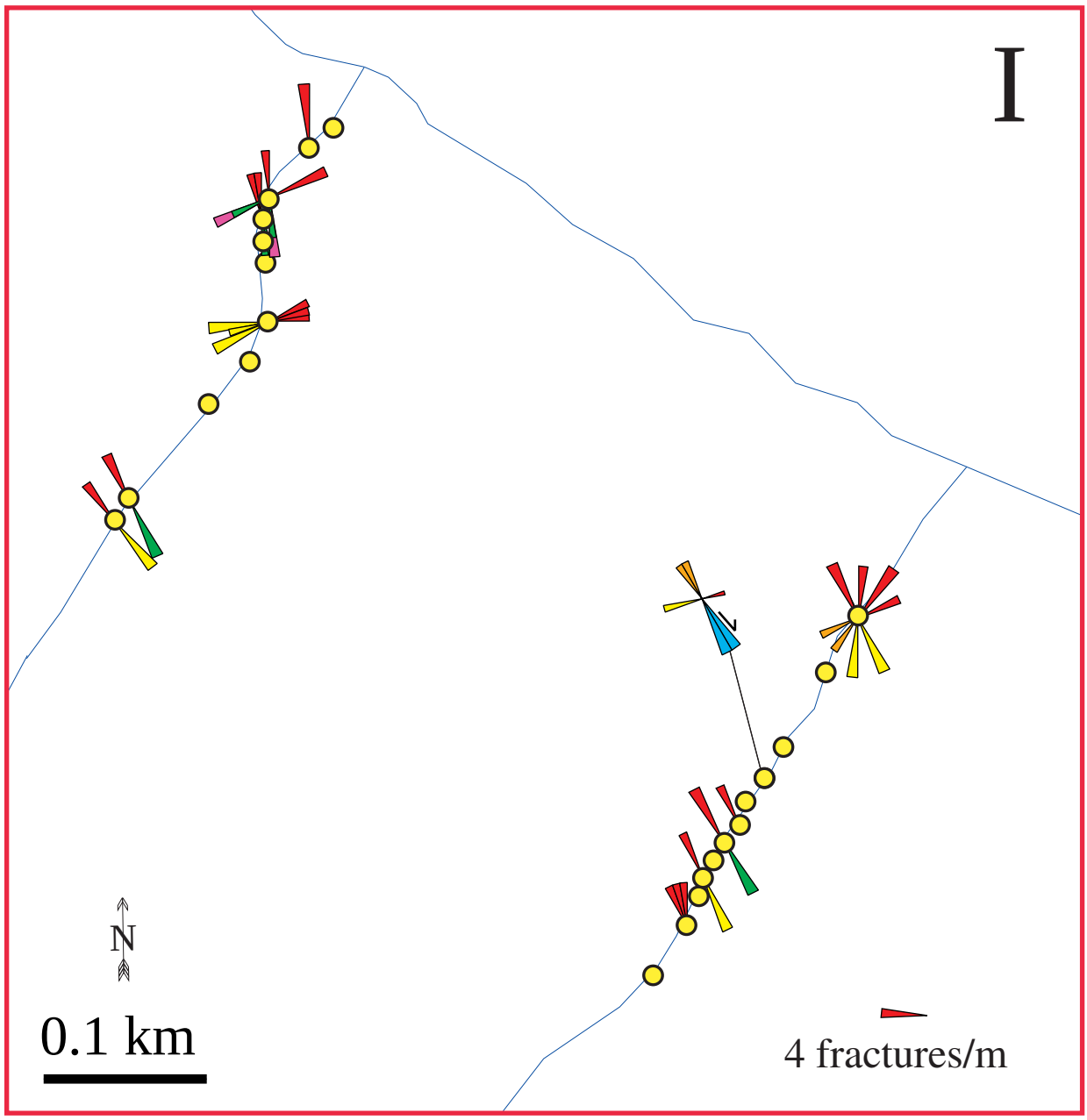


FIGURE 3.1-56

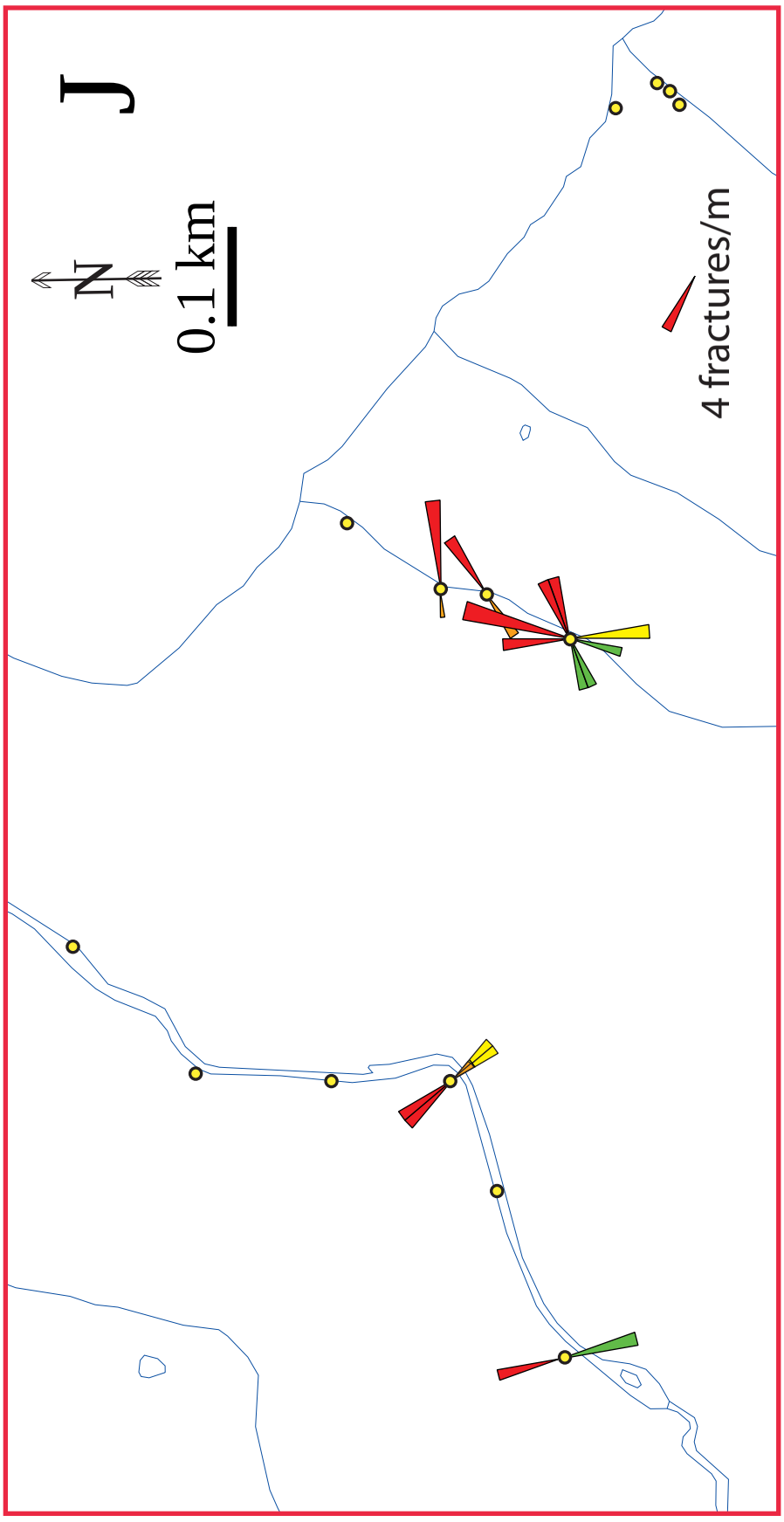


FIGURE 3.1-57

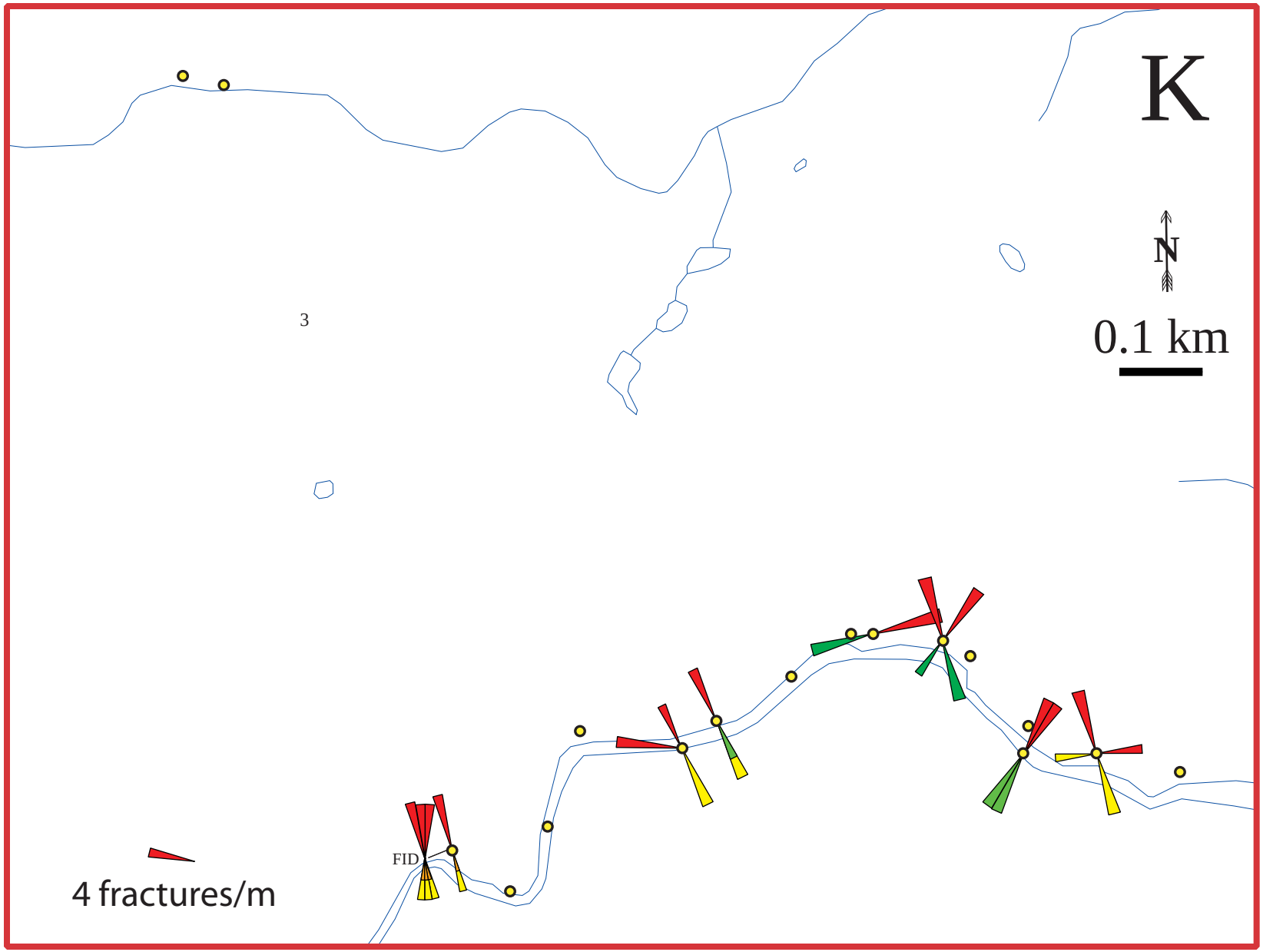


FIGURE 3.1-58

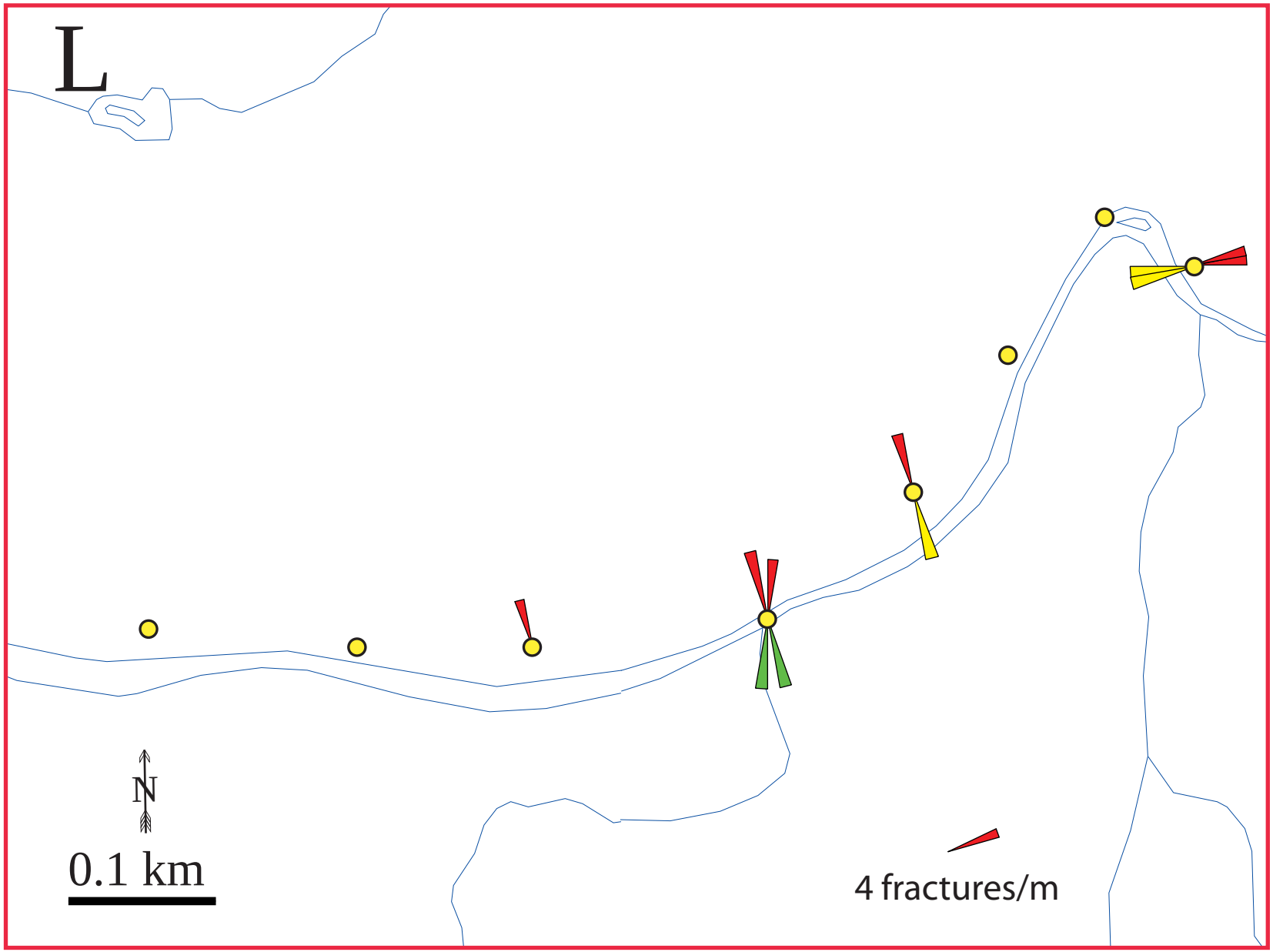


FIGURE 3.1-59

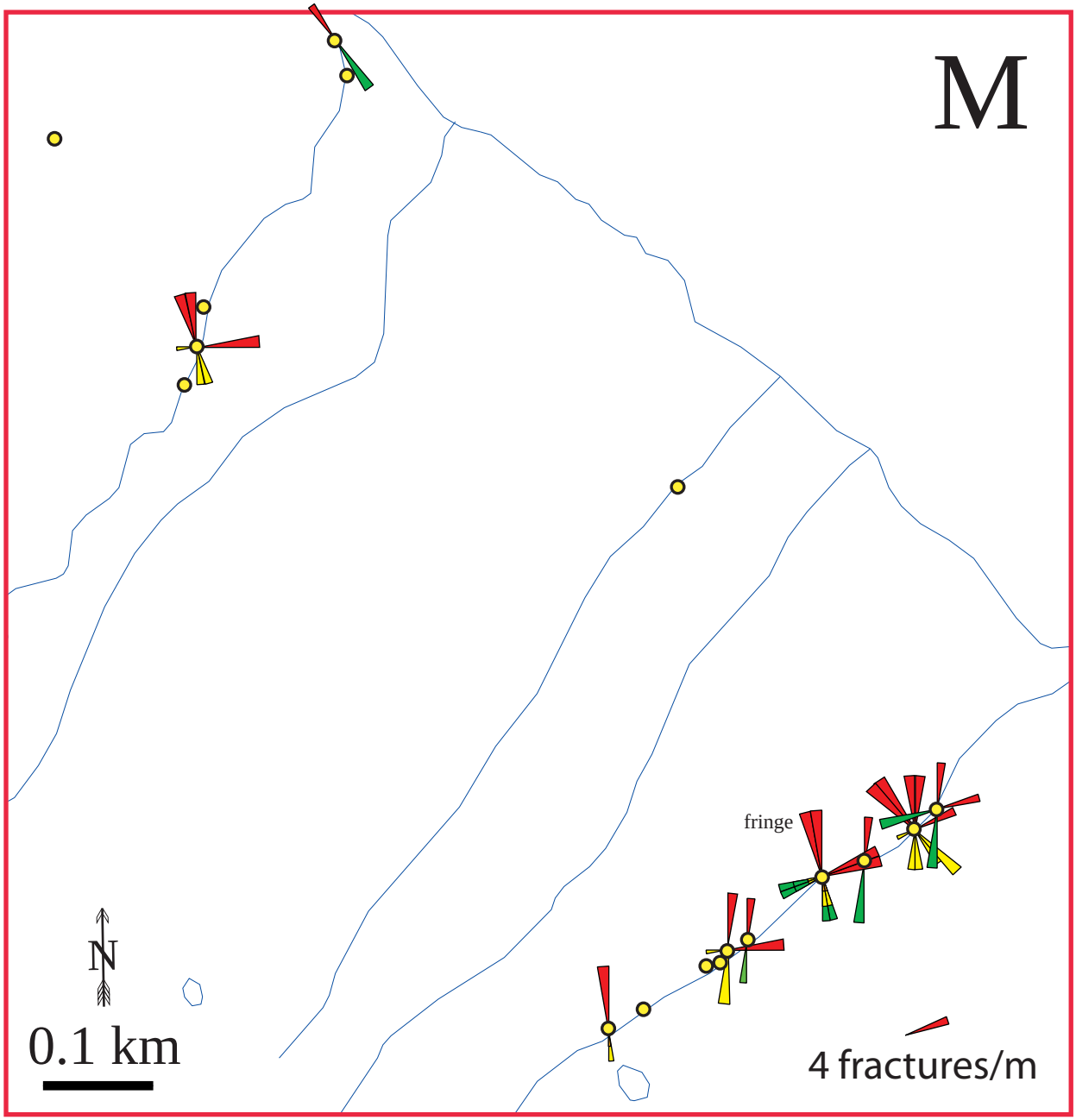


FIGURE 3.1-60

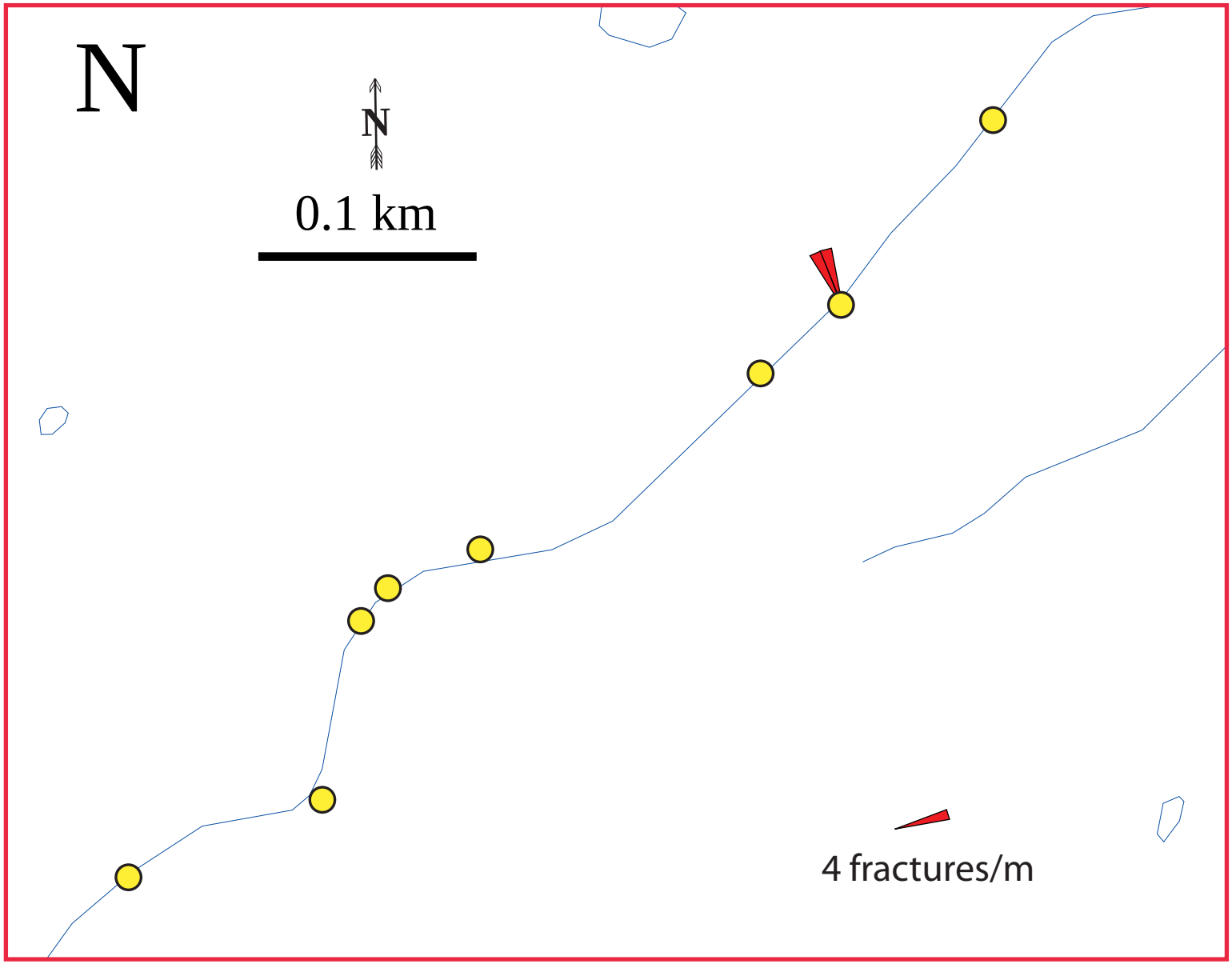


FIGURE 3.1-61

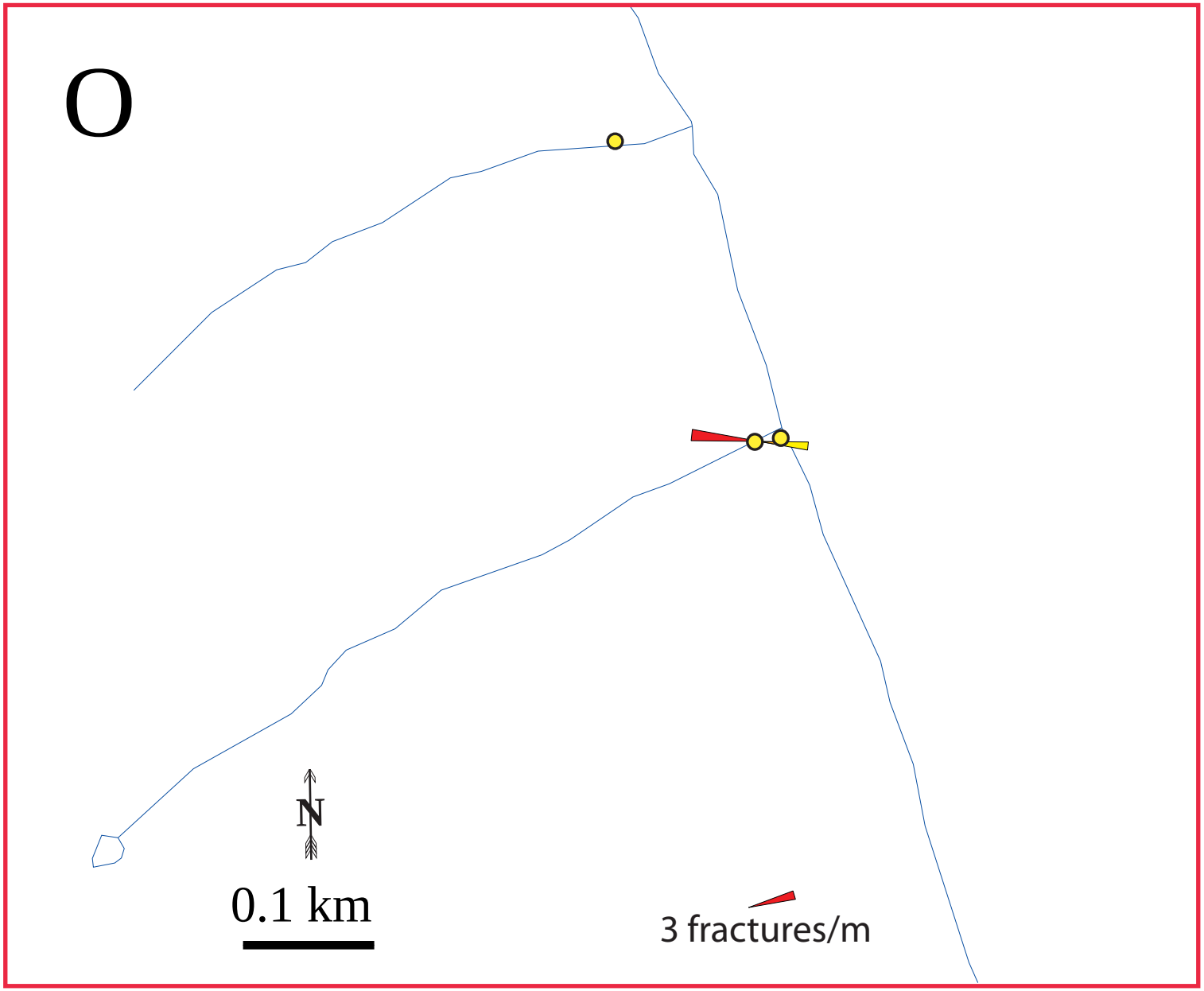


FIGURE 3.1-62

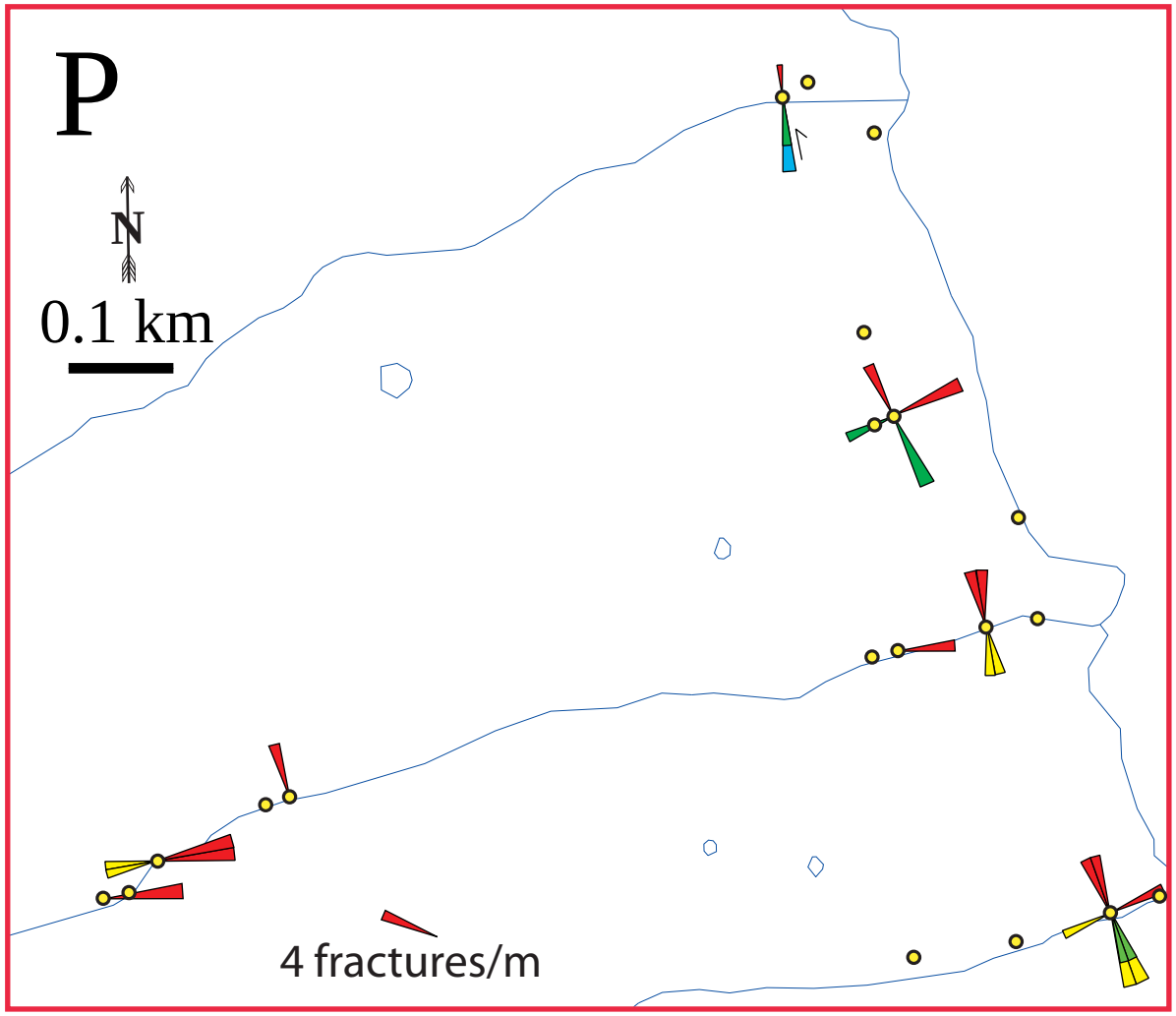


FIGURE 3.1-63

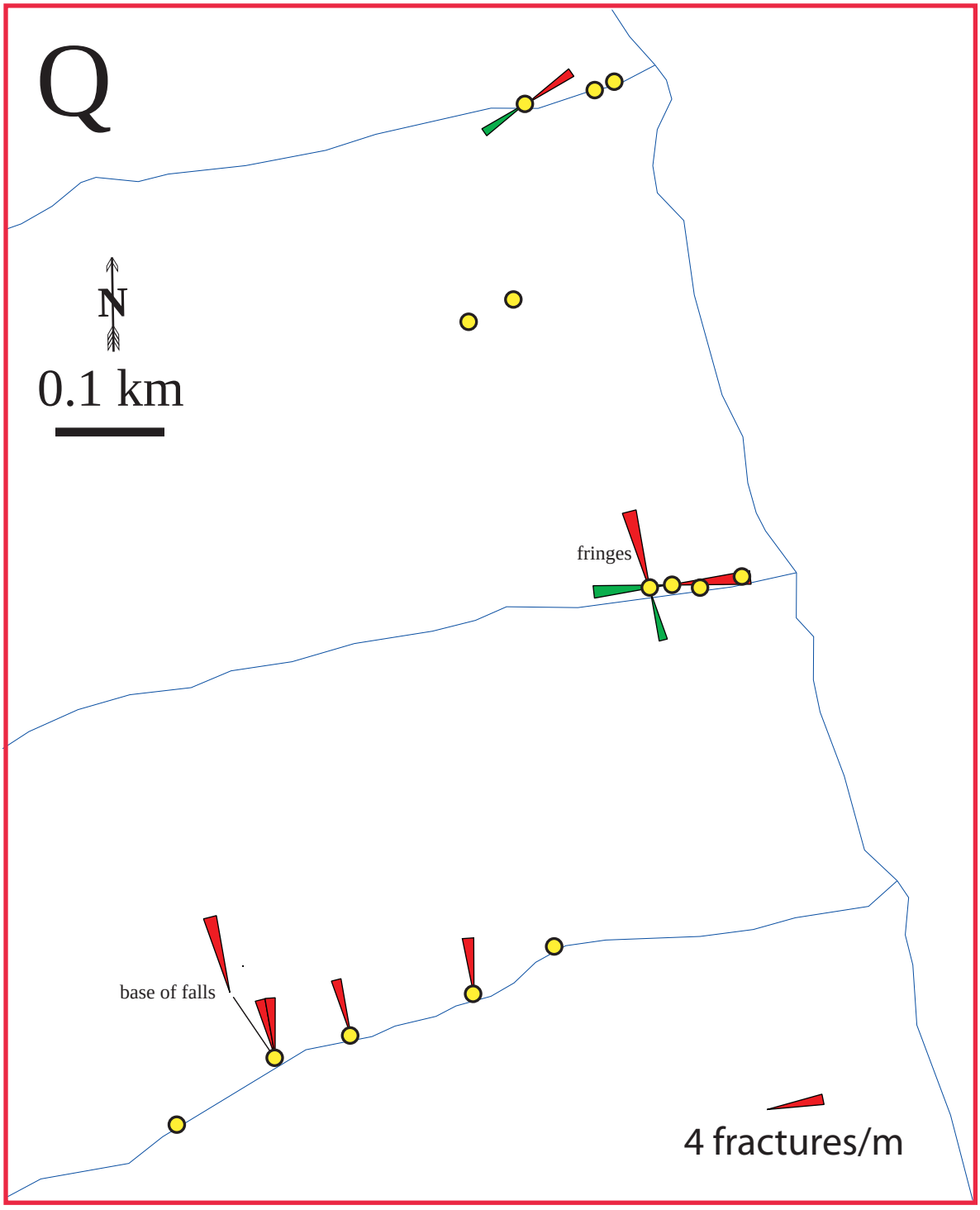


FIGURE 3.1-64

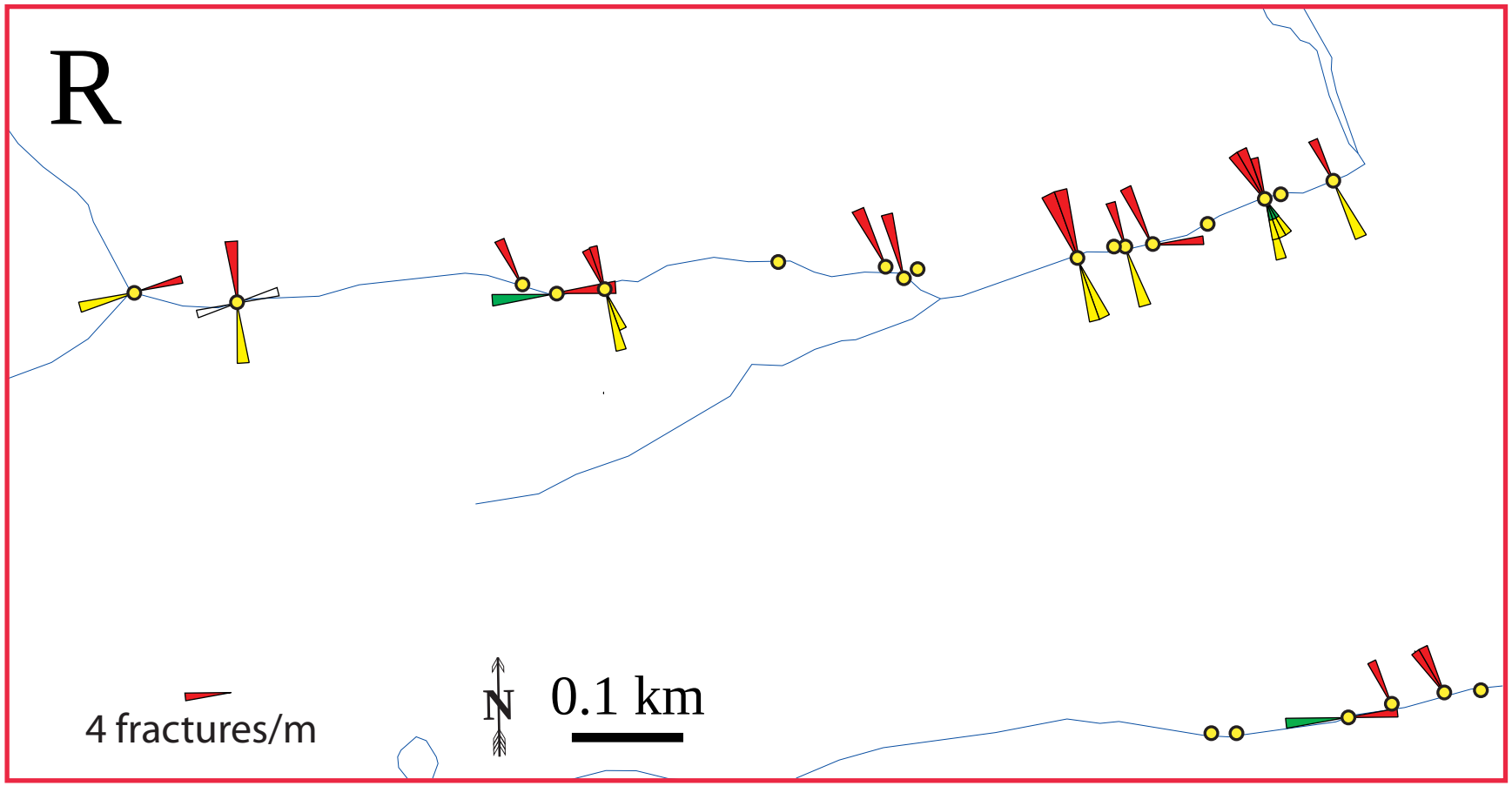


FIGURE 3.1-65

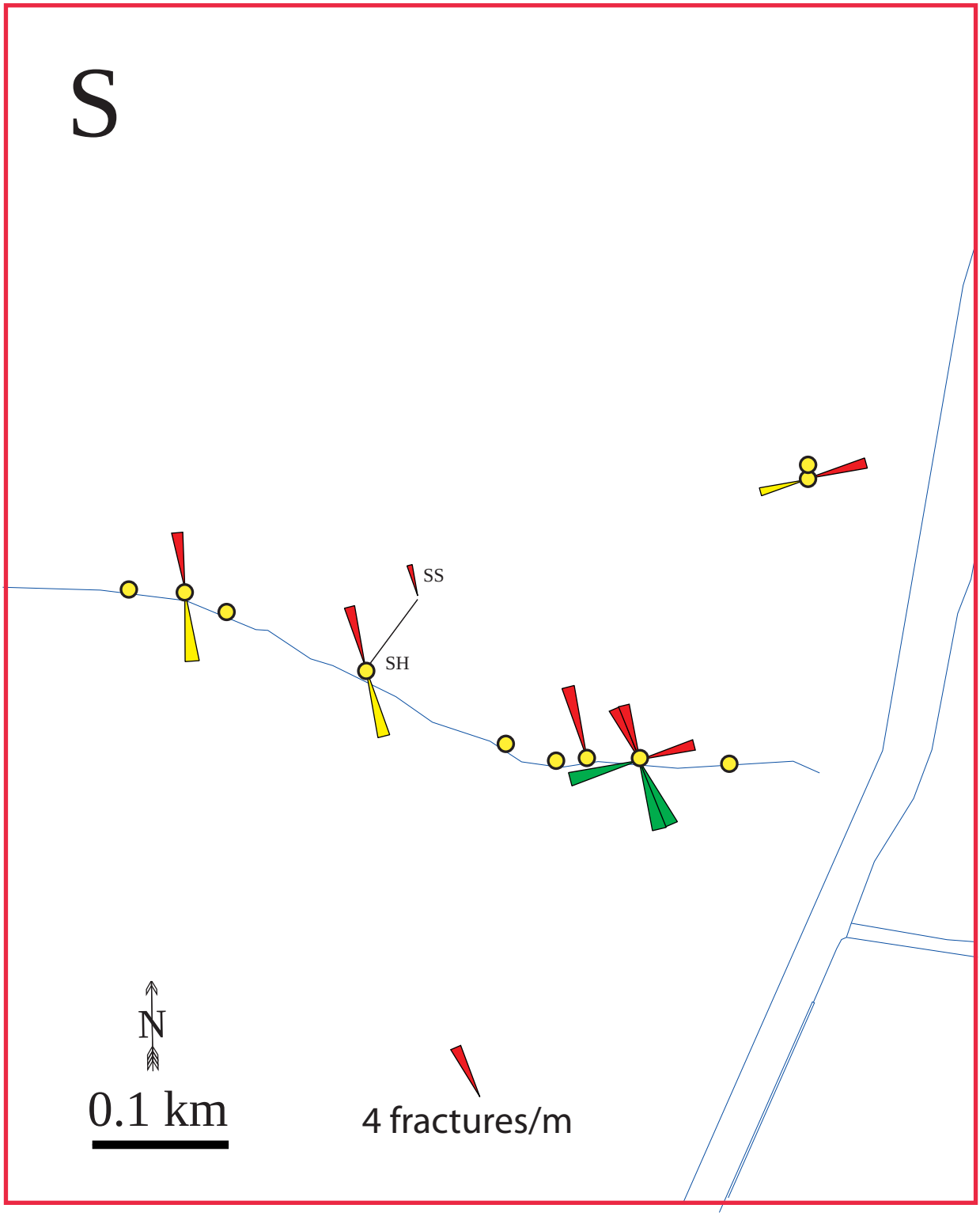


FIGURE 3.1-66

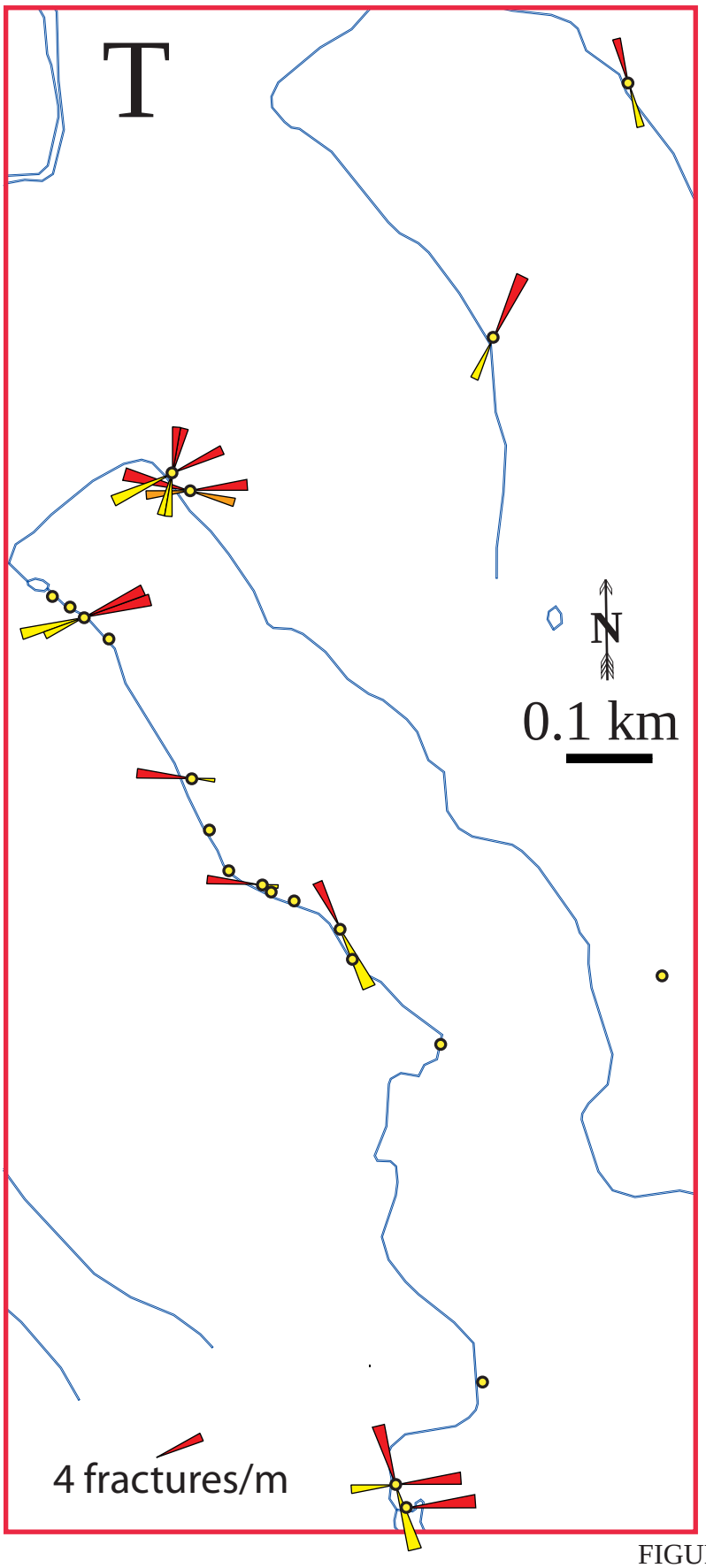


FIGURE 3.1-67

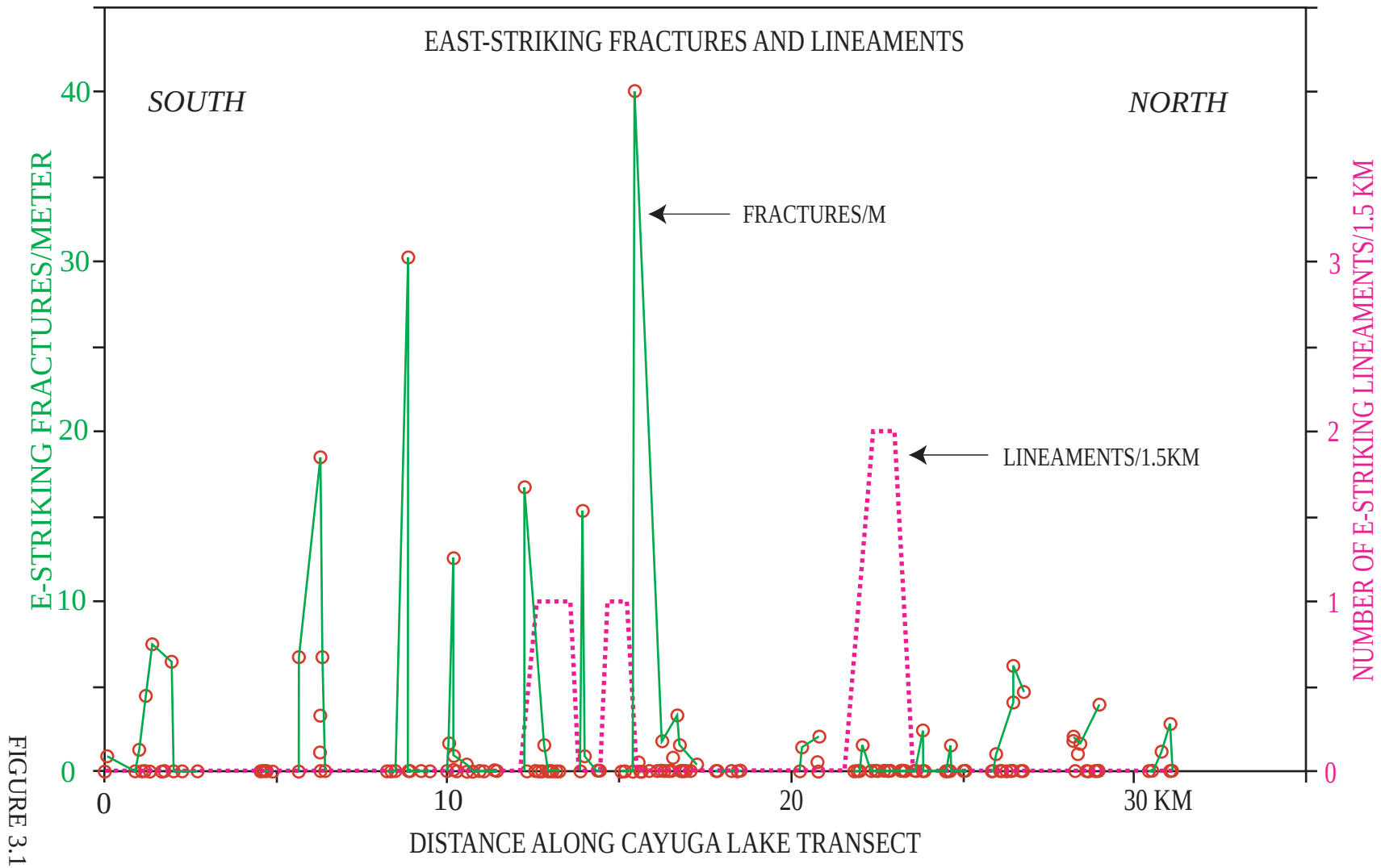

EAST-STRIKING FRACTURES AND LINEAMENTS
SOUTH
NORTH
FRACTURES/M
LINEAMENTS/1.5KM
E-STRIKING FRACTURES/METER
NUMBER OF E-STRIKING LINEAMENTS/1.5 KM
40
30
20
10
0
3
2
1
0
0
10
20
30 KM
DISTANCE ALONG CAYUGA LAKE TRANSECT

FIGURE 3.1-68

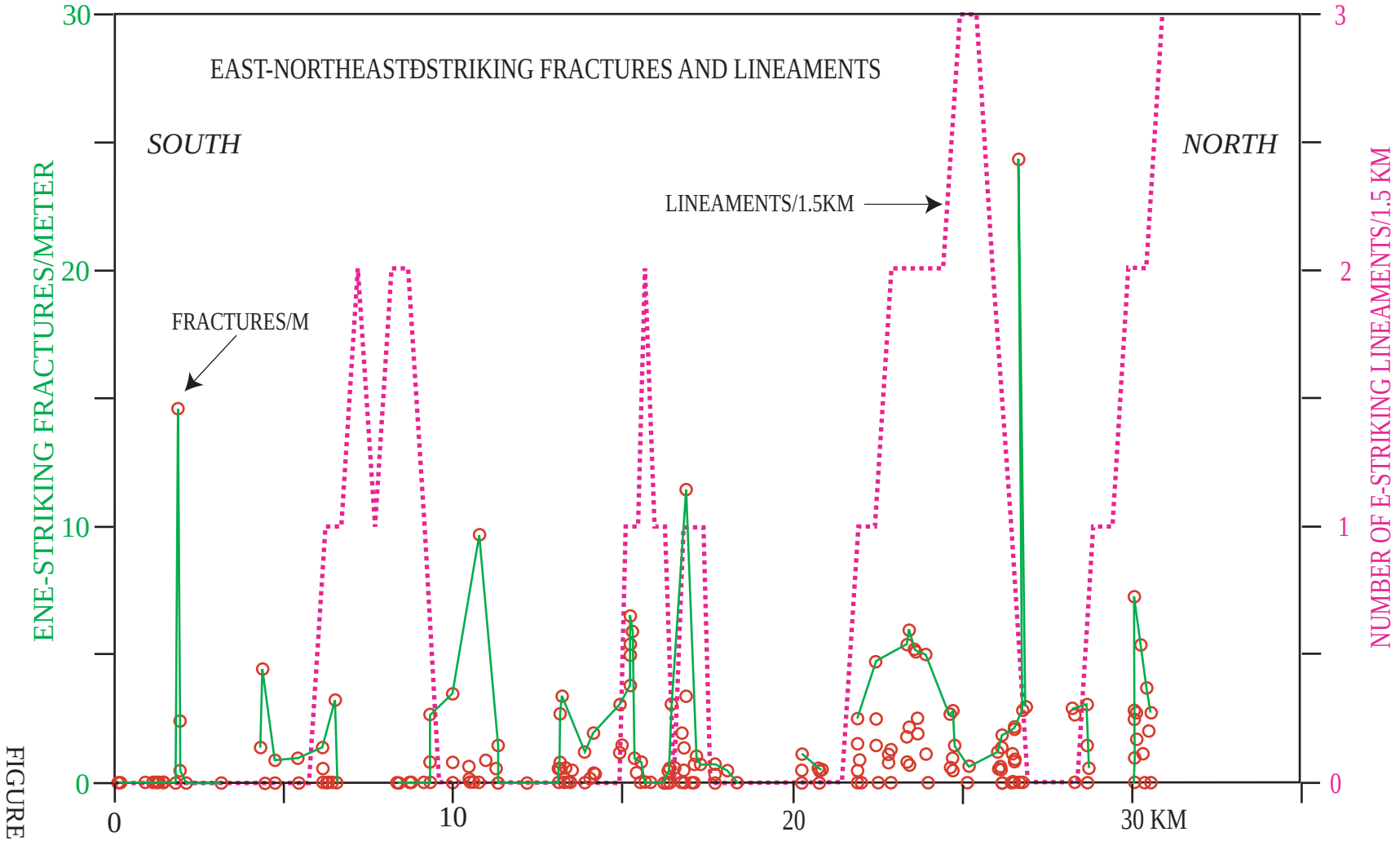

EAST-NORTHEASTÐSTRIKING FRACTURES AND LINEAMENTS
SOUTH
NORTH
LINEAMENTS/1.5KM
FRACTURES/M
ENE-STRIKING FRACTURES/METER
NUMBER OF E-STRIKING LINEAMENTS/1.5 KM
30
20
10
0
3
2
1
0
0
10
20
30 KM
DISTANCE ALONG CAYUGA LAKE TRANSECT

FIGURE 3.1-69